Nature and Essence in Aristotle's Logical and Biological works

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Ceci n' est pas un moto

ABSTRACT

Aristotle holds that some of the predicates that are true of a subject, signify what the subject is. The definition that states what a subject is, is composed out of such predicates, and signifies the essence or nature of the subject. I examine the grounds for distinguishing these predicates in Aristotle's works and I focus on the case of living kinds. In the first part I consider Aristotle's logical works, where the distinction rests on priority relations that relate to explanatory considerations. Given the subjects of a domain or genus studied by a science the predicates that are explanatorily more basic form the essence of those subjects. The aim of scientific understanding is to study the explanatory patterns within a genus; patterns that will be different in different sciences. In the case of the subject-genus of biology the explanatory patterns are determined by teleological relations. In the second part, I consider Aristotle's views on teleological explanation in biology, and in particular what forms the basis of these explanations, thus determining the order of priorities with respect to the nature or essence of the subjects studied in biology.

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ALEXANDER OF APHRODISIAS

In Met.	*In Metaphysica*
In Top.	*In Topica*

ARISTOTLE

APo.	*Posterior Analytics*
APr.	*Prior Analytics*
Cat.	*Categories*
dAn.	*De Anima*
EN	*Nicomachean Ethics*
GA	*Generation of Animals*
GC	*Generation and Corruption*
HA	*Historia Animalium*
JSVM	*De Juventute et Senectute De Vita et Morte*
IA	*De Incessu Animalium*
MA	*De Motu Animalium*
Met.	*Metaphysics*
PA	*Parts of Animals*
Top.	*Topics*

MICHAEL OF EPHESUS

In Gen.An.	*In Genrationem Animalium*

PHILOPONUS

In APo.	*In Analytica Posteriora*
In Phys.	*In Physica*

SIMPLICIUS

In Phys.	*In Physica*
In Cat.	*In Categories*

THEMISTIUS

In APo.	*In Analytica Posteriora*

1. Modality and Nature

How are we to define the nature of an object? Is the nature of an object that which it cannot exist without? Is the nature of an object what that object is? Is the nature of an object determined by what it is developing into? According to contemporary modal accounts a natural, i.e. essential, property of an entity x is a property that x cannot exist without or one that x possesses in all possible worlds where it exists. Let us name this criterion the survivability criterion. Aristotle, on the other hand, had a much richer account of what constitutes the nature of living things. The natures of living things are their teleologically functioning internal principles of change and rest which are identified with their form. These natures are essences signified by explanatory definitions that account for this teleological order in living things.[1] This is not just a dated doctrine, but a philosophical view whose motivation, or part thereof, is shared by contemporary philosophers. Recently Kit Fine has argued against the survivability criterion that it fails to distinguish between properties that constitute the nature of x and properties that are merely consequences of x's nature or necessary truths about the world. Fine's claim is that the survivability criterion is not sufficient for determining the nature of x. His own solution is that it is the definition of x that provides a sufficient criterion for this determination. Fine's solution, and especially his motivation, has affinities with Aristotle's concept of the nature of x being what is expressed by the definition of x.[2] This stance against the sufficiency of the survivability criterion

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[1] That is for things that have a nature their essence is identical with that thing's nature. The converse does not hold since there are essences of things that do not exist by nature. The link between nature and essence is evident from the opening chapters of Aristotle's positive account of Nature in *Physics* II. Nature is linked with essence (οὐσία) at *Phys.* II.1 193a20. At 193a30-1 one understanding of the nature of x, the one that is relevant to our discussion, is identified with the form of x according to the account or definition of x. This account must be the account of the essence, hence the association of nature and essence. Also, the formal cause is identified directly with essence (τὸ τί ἦν εἶναι) at II.3 194a21 (cf. 194b26-7).

[2] Fine offers two alternative formulations of the rival modal account: 'At its very simplest, it takes an object to have a property essentially just in case it is necessary that the object has the property. But there are two variants... One variant makes the necessary possession conditional on existence: an object is taken to have a property essentially just in case it is necessary that the object

makes the study of Aristotle's views on nature and essence all the more relevant to contemporary problems.

Further, some Aristotelian commentators raise doubts about whether the survivability criterion constitutes even a necessary criterion for picking out the natural or essential properties of an entity.[3] Although I will not engage in the latter controversy, I do take Aristotle's concept of nature to be built on grounds independent of survivability. The concept of nature, and consequently that of the essence of living things, offers a significantly different model from, and an alternative to, the modern accounts where modal (possible worlds) intuitions are decisive in understanding essential properties. I believe that this holds even though it seems that there is not one single concept of nature used rigidly throughout the Aristotelian corpus. Rather Aristotle modifies or expands his uses, and redirects his focus in different works. I will nor pursue here the questions of whether there is a unified concept of nature operative in the corpus, or, if nature is not univocal, what the element is

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has the property if it exists. The other variant makes the necessary conditional upon identity: an object is taken to have a property essentially just in case it is necessary that the object has the property if it is identical to that very object.' (1994:3-4) For a formulation of the criterion see also Graeme Forbes. (1997:516) Variants of this view are expressed in G. E. Moore's 'External and Internal Relations', *Proceedings of the Aristotelian Society* (1919), and in Saul Kripke's *Naming and Necessity* (Cambridge, 1980). For a detailed comparison between Kripke's essentialism and Aristotle's account of essences see Charlotte Witt. (1989:180 ff.) One of the key differences between the two accounts lies, for Witt, in the fact that Aristotle 'determines what is essential not by reflecting on the identity of an individual but by considering how to define an individual.' (1989:189)

The modal conception of essential properties is equivalent to an understanding of essential properties in terms of the survivability criterion. Fine argues that modal concepts are insensitive to essentialist facts. Different sets of essentialist truths can give rise to the same set of modal truths. So essentialist facts about identity are not sufficiently determined by modal facts (a similar view is expressed by E.J. Lowe (1999:149)) Fine's solution is to replace the modal approach with the Lockean idea of real definition (see also Forbes (1997: 530-31)). The necessary properties that fall outside the scope of the essence include (a) properties derived from truths of logic, and (b) improper properties. Although Fine refers to the Aristotelian distinction between essential properties included in the definition and merely necessary ones, his definition is wider than Aristotle's. (1994:2) Aristotle identifies the essence of x, in the case of organisms, with the nature of x. But not everything that belongs to x by nature or according to nature is included in this nature. There is evidence that a criterion equivalent to survivability is insufficient in Aristotle in *Top.* I.5 102a17 ff., V.1 128b16-20, 128b34-129a5.

[3] That the survivability criterion is not even a necessary condition in Aristotle has been proposed recently by Sheldon M. Cohen. (1996:1-3, 157 ff.) Cohen puts forward examples from Aristotle's elemental theory, according to which a portion of, say, fire may lose one of its essential properties without thereby ceasing to be fire. (1996:41-2) A similar skepticism is expressed by Daniel Bonevac. (2000:183-4)

that unifies its different uses. I will concentrate instead on a close examination of how the concept is introduced in the opening chapter of *Physics* II. I believe that the ideas and arguments introduced there indicate certain basic characteristics of the concept that play a pre-eminent role at least in the biological works.

The definition of nature in *Physics* II.1 and the arguments that support it, imply that the concept of nature or essence of organisms is not grounded on modal considerations. Aristotle distinguishes between something *having a nature* and something being *according to nature*.[4] Natures are givens in the world. What derives from them is according to nature or due to that nature. Necessity can belong to properties on either side of the 'natural – according to nature' divide. Natures are ontological primitives in the world, but the concept of 'nature' is not a primitive; it receives a teleological analysis in Aristotle's system. Natures are ends, and as such they are completion points of developmental processes. Natures are realisations and fulfillments of ends. More loosely, they are self-sufficient packages for the actualisation of ends, giving rise to the generation of an entity-with-a-goal and concluding with the entity's corruption, achieving the fulfillment of the goal along the way. On my understanding the self-sufficiency of ends in nature guides Aristotle in assuming a bold, but inspired principle in his metaphysics of natural substance: the oneness of the driving force and its goal, namely, the oneness of the efficient cause and the final cause of a substance. The embodied goal instigates the process which leads to its own fulfillment.

2. The Essential/ Non-essential divide in the logical works.

The arguments in *Physics* II.1, and book II as a whole, are conducted at a general level. They are not presented in a way that will account for the way in which the division between essential and non-essential features of a living thing, or of a thing that exists by nature, is

drawn. For an answer to this question one needs to study the biological works as well as the methodological discussions in the logical works, especially the *Topics* and the *Posterior Analytics* where the notions of essence and definition are treated extensively. This is the objective of chapters 2 to 5. But first, two preliminary issues can be addressed here.

First, it is not clear whether the method put forward in the logical works has any bearing on the method used in the physical or biological works. Hence it is not clear what the exact use of the claims made there concerning definition and essence can be for a study of the biological works. Nevertheless, although there is no agreement what the inquiry of which the *Analytics* present the method[5] is for, this does not imply that the remarks made there are unconnected to the method followed in scientific works such as the biological works. A similar claim could be made about the *Topics*. Although the aim of these books is remote to that of the physical works, this does not entail that the claims made about essence and definition must be in tension with claims on the same issues that can be extracted from the scientific works. I will argue that at least a number of claims made in the *Topics* are followed or developed further in the *Analytics*, in a way that is in accordance with views concerning the nature of living kinds expressed in Aristotle's biology.

Secondly, there is the infamous absence of the matter/form distinction from the logical works, which is part of the argument for their early composition. Now, since, as is evident from *Phys.* II.1, this distinction becomes crucial for the division between essential and non-essential features, the remarks of texts where the matter/form distinction is absent can only be of a limited use for a study on essence or definition. Such an argument assumes that the matter/form distinction is introduced in a way that neglects the studies included in the logical works; and this cannot simply be taken for granted. Instead I wish to consider the claims

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[4] To put it roughly, 'nature' is identified with that which is self-generated. Properties that are not controlling this process of self-generation may follow from or be according to this 'nature' but they are not part of its definition.

[5] It is certainly not the method of scientific discovery for the method presented is not followed in the scientific works.

made in the latter works and compare them with the claims made in the biological studies. I will argue that a number of elements present in the conception of definition in the logical works are taken into account in the later works. My analysis of the *Topics* and *Posterior Analytics* will focus on these elements.

The *Topics* discussion of definition exhibits at least three such elements. (chapter 2) First, the distinction between predicables that are definitory parts and those that are not depends on predicative relations where the predicate reveals what the subject is, i.e. it is predicated of that subject in the first figure of predication. Aristotle agues that the most important element related in this way to its subject and the most important element in the definition of that subject is its genus. This constitutes the most significant determination in the course of defining a subject, at least in the *Topics*, and it remains an important concept in the *Analytics* and in the biological treatises, or so I will argue.

This leads to the second consideration that can be extracted from the *Topics*. (chapter 3) Defining depends on a comparative study of the differences and similarities of a number of subjects or *definienda* under a common genus. The remarks on the method of the study of differences and similarities in the *Topics* are very brief.[6] However, the study seems closely connected to the method of division -the two of them involve a number of common steps- which is present in some way or other in the later works. The third and final point concerns the relations between definitory predicables, the parts of definitions, and the pre-eminence of the common genus in the *Topics*. These relations constitute an order of natural priorities, determined by the criterion of non-reciprocation as to implication of existence which is put forward in the *Topics* and is also discussed in the concluding chapters of the *Categories*. The determination of what counts as part of the essence of a subject depends on this order of priorities which results in the formulation of definitions in terms of a genus and one or more

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[6] The study of differences and similarities is presented in *Topics* I.16-18. Further, the *topoi* presented in books IV on *genera*, V on *propria*, and VI on definitions offer complementary information especially with respect to the predicative relations between definitory predicables.

differentiae. I conclude chapter 3 with a consideration of what kind of justification these three aspects of the theory of definition in the *Topics* offer to the distinction between essential and non-essential predicates.

The order of natural priorities as discussed in the *Topics* and the *Categories* is drastically refined in the light of the theory of scientific understanding formulated in the *Analytics*. Definition depends on priorities relating to *aitiological* considerations and more precisely on the criterion of what are the explanatory grounds for something to be the case, grounds that will also show why that thing cannot be otherwise. Thus the notion of explanatory grounds is pre-eminent in dividing essential from non-essential features of a subject. This can be interpreted as an implicit rejection of the way the distinction is drawn in the *Topics* and of the corresponding model of definition there. In chapters 5 and 6 I examine to what extent the three main elements of the latter model continue to influence Aristotle's remarks concerning essence and definition. I argue that considerations relating to the pre-eminence of the common genus between a number of subjects, a division between the different ways predicates are predicated of a subject, as well as the method of division are present in the *Analytics* model and are, to some extent, compatible with the project of formulating explanatory definitions.

A further important element in the study of definitions, arising from the *Analytics* focus on explanation, relates to the explanatory practices that correspond to the subject genus that is the object of each science. There are different explanatory practices appropriate for different subject genera, or fields of study. Thus in biology, dealing with subjects that function as teleologically organised systems, pre-eminence must be given to teleological explanation. The explanatory patterns that will enable the natural scientist in grasping the priority relations that will appropriately explain the nature of the subjects he is studying will rest with teleological explanations. The second part deals with these explanations in biology.

3. Nature and Essence in the biological works

I would like to give an overview of the argument in chapters 6-9 by addressing two issues. First, to point briefly to some tension that can be detected between the general way the nature or essence of living things is defined in *Physics* II and the concept of this nature reflected in the detailed explanations in biology. Secondly, to make some general remarks concerning teleological explanation that give some context to, and clarify the motivation for, the discussion in chapters 6-9.

In *Physics* II.1 form is identified with the nature of a living thing as an inner principle of change. Matter is also, though in some different sense, identified as part of the nature of a living thing.[7] Standardly the essence or definition of *X* is identified with the form of *X*. It follows that only a subset of the natural properties of a living thing will make it into the essence or definition of that thing. However, it is far from obvious that definition is univocal.[8] It seems that one kind of definition, that includes definitions of composite or sensible substances, will include both formal and material aspects of the nature of the *definiendum*. So it seems as if in these cases the essential/non-essential divide cannot be based on a neat distinction between matter and form. How is the natural scientist supposed

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[7] The two claims are introduced in *Physics* II.1. For the priority or supremacy of formal over material natures see *Phys* II.1 192b13-5; *PA* I.1 640b28. For a discussion of the relation between formal and material natures focusing on the *PA* see Lennox (2001b:163-181).

[8] Three kinds of definition are distinguished in *dA* I.1 403a30ff.: (1) of the form or end of X, (2) of the (proximate) matter of X, (3) of the enmattered form of X as serving certain ends. For (3) as the object of physics see *Met.* VI.1 1025b26-1026a6 with *Phys.* II.2 (see also VII.8 1033b24-6; 10 1035b28-31; 11 1036b21-32; 1037a21-b7. The latter passages from *Met.* VII and the kinds of definition as related to the inquiry for primary substance in *Met.* VII are discussed by Frede (1990:113) who argues that 'it is only in a special sense of definition and in the particular context of natural philosophy that natural substances are defined with reference to both matter and form.' (1990:114) In, what Frede calls, the traditional/standard sense what is referred to by the definition of *X* is the form of *X*. (See also Morrison's reply (1990:133-44) to Frede's interpretation of *Met.* VII.10-11) With respect to the definitions of composite substances such as living things: do they include some reference to matter? And if so, are they treated as definitions of essences? Frede answers both questions in the negative while Morrison argues that the physicist's 'What is X?' is answered by an essence-giving definition which refers to the matter of the definiendum. I will not attempt a discussion of the implications that can be derived from *Met.* VII for Aristotelian definitions. I will concentrate on Aristotle's practice in biology, and I will argue that material aspects are somehow included in definitory statements. Morrison's arguments allow that this claim is not incompatible with the claims in the *Metaphysics*.

to divide between properties that are of the essence or substantial nature of the living thing from properties that are not? Also, even if genuine definitions do not include references to material aspects of organisms, and thus the matter-form distinction does correspond to the division between definitional and non-definitional properties, the same question must be addressed. What criteria are applied in order to get the essential properties of a living thing so as to formulate a definition of the natural kind it belongs to?[9]

It seems that the division is based on priority relations between the natural features (activities or parts) of organisms, which are the result of two kinds of teleological considerations corresponding to (a) function and (b) generation. To the extent that what is explanatorily basic has a better claim for being included in the account of what a living thing is, and explanation in biology is teleological, questions concerning the functions and the generation process of organisms, will settle issues concerning their natures. In the context of biology teleological considerations take precedence over a sharp distinction between material and formal aspect of living things for determining their substantial natures.

Aristotelian organisms are teleologically functioning systems. Their form, identified as their soul, consists in a number of capacities (the generative, nutritive, sensitive etc. soul-faculties) that aim at the corresponding activities. Thus a living thing *L* with soul-functions, s_1, $s_2 \ldots s_n$ is for a state of complete development *C*, where *C* consists in the unimpeded exercise of $s_1 \ldots s_n$ (*C* is the state where these capacities reach full actuality). According to one line of explaining teleology in Aristotle's biology, *L* is (teleologically) for *C* iff (i) *L* displays the activities constitutive of *C*, and (ii) *L* comes to be for *C*. Condition (II) requires

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[9] There is a fundamental objection to this way of putting the question following from Balme's claim that 'definition and its associated logical apparatus became as irrelevant to Aristotle as it has become to modern philosophers of nature.' (1990:54) This does not necessarily mean that the distinction between essential/definitory and non-essential/non-definitory is irrelevant to the biological treatises. Rather it is directed against a stronger claim, namely that the aim of Aristotelian biology is to arrive at a list of definitions of natural kinds, which is not endorsed here. I suggest that since definition and essence rely on explanatory facts, the explanations offered in biology indicate Aristotle's views on essence and definition, and allow one to draw implications concerning the essence of living kinds.

that *L*'s generation aims at *C*.[10] If (ii) is a credible condition, then *L*'s nature cannot be just the combination of activities constituting *C* but it must also include or depend on a description of *L* as coming to be for *C*. In other words *L*'s substantial nature does not solely depend on the order displayed in *C*, an order of activities constituting *C* as something over and above *L*'s material properties, but it must also depend on a generation process that is for this order. Natural generation is essentially such that it aims at creating the order characteristic of *C*, i.e. it plays some part in explaining why *L* is for *C*, and thus it will offer some indications concerning the divide between essential and non-essential properties. If so the account of generation of living things in the *GA* should offer evidence concerning the divide between essential and non-essential or what is explanatorily more basic and what is explanatorily derivative.

In the *GA* account the manner in which living things reproduce by means of their generative parts, the order of the formation of the parts and their active contribution to the generation process are taken into consideration.[11] These considerations result, or at least correspond, to a network of priority relations between the parts and the corresponding activities with respect to the order of being and explanation. My aim will be to examine these priority relations and investigate what ultimately grounds them, i.e., what sanctions teleological explanation. The reason why the natural features of organisms are explained in terms of functions which are beneficial to the organism depends on the fact that these parts and features are coming to be for the sake of performing these functions, i.e. they come to be for the sake of the organism as a well-functioning system. The mechanism on which this unity between the two forms of teleological statements is grounded are the, closely

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[10] This analysis is proposed by Larry Wright (1976:81), as a modification of Taylor's schema for teleological explanation. (cf. Taylor (1964:ch.1)) Gotthelf argues that this analysis captures Aristotle's teleology, given a necessary modification of condition (II). (1987:241) Wright's (II) would read: '*L* is there because it does (results in) *C*' whereas Gotthelf's reformulation would read: '*L* came to be for the sake of doing (making possible etc.) *C*.'

[11] E.g. *GA* II.6 742a19-23.

associated, generative and nutritive capacities of the organism. In that respect there are at least three questions that need to be raised.

The first relates to the way this mechanism grounds the two forms of teleological explanation with respect to (a) generation and (b) function. The development of the organism follows, roughly, a teleological order, and it is the nutritive faculty that regulates this order by dividing, selecting and directing the nutriment appropriately.[12] The result is a state of full actuality or maturity where the organism can exercise the capacities characteristic of its kind. The nutritive faculty also accounts for the maintenance of this state. Moreover, the reason why development is thus regulated is that the generative capacity of living things aims at reproducing the same forms (at least specifically the same) in a state of full actuality. The generative capacity of the fully mature individual is for reproducing this state.[13] And this is so because regular recurrence of these forms in full actuality is what the natural world aims at as something good.[14] So the exercises of both generative and nutritive faculty are for the same actuality.[15]

In chapter 6 I address the first term of this identity between the two soul-faculties, namely generative soul. I examine the question concerning the reproductive capacity of living things, in natural generation, and the grounds for the persistence of natural kinds.

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[12] Parts formed early in the developmental process and active as efficient causes during that process, such as the heart, are more honorable, explanatorily more basic and part of the substantial nature of the entity.

[13] Roughly the account of generation involves (a) the directive agency of form, which aims at the order of completion in *C*, as (b) constrained by the material circumstances and the environment. Lennox argues that the formal nature is a goal-directed agent the actions of which are selective and informative but which is also constrained by the corresponding material nature. (2001b:183)

[14] Several remarks may suggest that the generative capacity aims at this state of full actuality as something good. However this view is under criticism by Gotthelf who takes it that this value is only derivative or secondary, and that the fact that the capacity aims at a state of full actuality is not analysed in terms of the good. I will not go into this controversy as it demands a close examination of *Met.* IX on the potentiality/actuality distinction and XII as well as *NE* I and X.

[15] If capacities are individuated by means of what their exercise tends to produce the above thoughts imply (a) a close connection between the two, and (b) the manner in which they support teleological explanation. But I will not endorse this claim here since I will not deal with the arguments concerning the individuation of changes; my arguments endorse the view that there is more to natural changes than just the final state towards which they aim.

Their persistence is based on the irreducible value in the natural world of being in full actuality, i.e. possessing the form characteristic of the natural kind the organism belongs to.

The second question, dealt with in chapter 7, is whether this generative/nutritive faculty is reducible to some lower-level material mechanism, such as vital heat. What is the role of efficient causes in generation? It was suggested that the distinction between what is essential and what is not is closely related to the nature of the efficient causes in animal generation, since what the organism is depends on what the organism was generated as. This seems to suggest that the form of the organism, or at least its generative/nutritive soul-faculty, must be actively directing the generation process as an efficient cause. But this claim is the object of controversy. There are passages in the corpus where the efficient causes are linked with the material ones and together are contrasted with formal/final causes. In other passages, however, efficient causes are more closely connected to formal/final causes as contrasted with the material ones.[16] The controversy arising from these conflicting remarks concerns the *basis* of teleological explanation.[17] There is a wide variety of views concerning what constitutes the basis for Aristotle's teleological statements. I will concentrate on two main groups of competing answers to that question.[18]

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[16] This tension points to the possibility that there are different ways in which the efficient cause is conceived or that there are both formal and material powers included in it. For the identity between efficient and formal/final causes see *Phys.* II.7 198a24-6; *dA* II.4 415b10-12; *PA* I.1 641a27. For the contrast between the two see *PA* II.1 646a24-35 (cf. Bradie & Miller (1999:80)). Bradie and Miller seek to reconcile the two views by pointing out that Aristotle refers to the final cause in two different ways: 'when he speaks of the final cause as the fully developed outcome of the process, he distinguishes it from the efficient cause at the start of the process... When he speaks of final causality as immanent throughout the life-process, he associates with the efficient cause or moving cause.' (*ibid.*) This question is also addressed by Frank Lewis (1988:54-98) and John Cooper (1982:197-198).

[17] On labeling the question thus and on classifying the answers I follow Gotthelf (1997c). He suggests a threefold division of questions concerning teleological explanation. In the first class, labeled *Analysis*, he classifies questions concerning the search for differences and similarities in the basic categories of teleological causation, i.e. (a) generation and (b) function of living organisms and human action. The second class, labeled *Basis*, investigates what facts ground the use of teleological explanation. Finally under the heading *Extent* he classifies questions concerning whether teleological causation extends further beyond human action, development, structure and functioning of living things to cover cases below or above this level (e.g. inanimate things or the Prime Mover correspondingly).

[18] Gotthelf distinguishes five general theses that divide the proposed interpretations into corresponding classes (1997c:75-78):

Perhaps the most influential representative of the first group is the line suggested by Gotthelf, that teleological explanation is based on an irreducible potential for form present from the outset of the generation process.[19] According to this line a material level account is not sufficient for accounting for the formation and functioning of living things. The formation and functioning of living things is subject to the influence of the form as a final cause, because these organisms possess from the outset a potentiality directed towards this form as an actuality.

According to an alternative group of interpretations, which take a broadly reductionist stance on the issue, the potential for form is reducible to some material element the activity of which sufficiently explains the formation of organisms. A radical version of this interpretation endorses the two following theses: (1) where finality applies there exists a chain of efficient/material causes, *C*, that fully necessitates exactly the same product governed by the formal/final causes (Full Necessitation Thesis), and (2) neither *C* nor any relevant extension of it does itself contain the formal/final cause of the effect as a member

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The *Strong Irreducibility Thesis*: 'teleological explanation is sanctioned by the absence of a... [sufficient] material level account, since that absence alone entails that the form of the living organism has a real causal role (as aim) in the organism's generation.' This is what Gotthelf labels an *irreducible potential for form.*

The *Pragmatic View*: Material efficient causes are sufficient in explaining the formation and functioning of living things. What sanctions teleological explanation is 'the fact that material level account fail to satisfy some pragmatic or subjective need we (sometimes) have for a certain type of explanation,' satisfied by teleological explanation. (Nussbaum (1972); Sorabji (1980))

The *Limited Irreducibility Thesis*: Material necessity sufficiently explains the formation and functioning of living things. It fails to account for the goodness which is irreducible to the material level. (Charles (1988))

The *Weak Irreducibility Thesis*: There is a potential for form irreducible to material necessity potential for form 'so long as there is a ''program'' in the seed which controls and regulates organic development... defined in terms of that form.' (Balme (1972); Bradie & Miller (1984/1999)).

The *Intrincic Causes/Anti-Eliminativist thesis*: Aristotle is not an anti-reductionist for he does not deny that the formation of living things is reducible to material necessities. What he denies is that their coming to be is accidental for it depends on 'an *intrinsic (efficient) cause* of the appropriate sort.' For some this intrinsic cause is 'something ''program''-like which insures a regular outcome' (Matthen (1989/1999)): 'the formal character of the outcome, the regularity of its production, and the need to define the initial material structure in terms of its ability to produce such a result, allow us to speak of that result as a final cause. An alternative version of this view holds that the efficient cause 'is one which not only guarantees that a living organism of a certain form regularly results, but one in which that intrinsic efficient cause is present because the result it produces is good.' [Gotthelf (1997c:78)]

[19] Gotthelf (1987b:204-242).

(Exclusivity Thesis).[20] The conjunction of (1) and (2) entails that there is at least one causal chain in the generation of a living thing that is independent of formal/final causes, i.e. it is *form-free*. On a weaker reductionist line, teleology is sanctioned by the fact that the movements of vital heat in the sire's semen embed the 'program' for the generation and development of the embryo.[21] Vital heat includes both formal powers (the 'program') and efficient ones (warmth). This version differs from the more radical interpretation in that the activity resulting in the generation of living things is not reducible to the activity of the four basic elements. Still it is in contrast with Gotthelf's interpretation because it reduces that activity to the movements of the element of vital heat which contains the form. So, to the extent that it relies on the reducibility of the form to the movements in the element of vital heat, it can be classified as reductionist. If on the other hand it claims that the activity of vital heat is dependent on the form, instead of the form being reducible to it, this line seems to collapse into the irreducible potential for form interpretation. Since I will focus on the claims concerning the reducibility of form to some element or other, it is not misleading to classify the two reductionist lines together as opposed to the claim that there is an irreducible potential for form which directs the generation of living things. I will argue against the weaker version, since a rejection of this weaker version, warrants, *a fortiori*, the rejection of the stronger one.[22]

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[20] The two theses are formulated by Frank Lewis. (1988:55-6) He defends the conjunction of the two theses. A similar position suggesting that connate *pneuma* can be characterised in terms of physical properties independent of its connection with soul is proposed by Charles. (1988:1-53)

[21] On this interpretation, although the potential for form is irreducible to the potential of the four elements, it is reducible either to a "program" somehow contained in the seed which controls and regulates the formation of the living thing [Bradie & Miller (1999); Freudenthal (1995); Reeve (2000;47-9)]; or to the activity of an intrinsic efficient cause such as the activity of vital heat. [Matthen (1999:278-296)] But there is something puzzling in the first line which uses the program metaphor. Either this program is a physically describable state which realises the potential for form in which case the view collapses into the view that there is an intrinsic efficient cause; or the program *is* the potential for form in which case one cannot reduce the potential to it.

[22] A brief statement of the controversy could be laid thus: There are two kinds of movements or powers, active and passive ones, by means of which a living thing is formed. (*GA* II.6 740b19 ff.) The passive power is attributed to the material element contributed by the female, while the active power residing in the male's semen, drives the generation process, in a way analogous to the movements of the craftsman in the production of artifacts, and it is identified as the efficient cause of the generation

In the course of this examination I will argue for the irreducibility of the potential for form to material necessities and to vital heat in particular. The efficient causal chain active in the generation of living things is not exhausted by the activity of this element. It includes, rather, the active involvement of the form as well as some parts of the organism which because of their explanatory role are considered to be parts of the essence of that organism. Vital heat is an instrument in the generation process and persistence of living things and their kinds cannot be accounted for by the activity of vital heat. I will try to corroborate this conclusion by considering generation and development in cases of natural generation.[23]

I will then try, in chapter 8, to extract some positive points concerning the generation of animals and the distinction between what counts as part of the substantial nature or essence and what not. The order of development and the instrumental relation between the parts of an organism plays a deciding role on how to draw this distinction.

There is here a set of questions on the way the dependency of definition on explanation influences the views about what constitutes the substantial nature of an organism. The relation of being explanatorily more basic is subject to degrees. Clearly, if explanation is to stop at some point, there must be a bottom level with respect to which nothing is explanatorily more basic. But in the case of living things there does not seem to be a unique feature such that explanations of all other features follow, ultimately, from it. There are some key factors, activities and parts, which in combination can provide explanation for further activities or parts of the organism. Both the *explanantia* and the *explananda* of this first stage of explanation can serve as explanatory for further activities and parts of the

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process. This active power is linked at times with the form of the generating male parent and at times with the operation of vital heat. If the active power is identified with the vital heat, either because the potential for form is reducible to the activity of vital heat, or because the causal chain involving the vital heat and the passive powers of the matter is *form-free*, then the vital heat does not depend on the active role of a formal cause. Hence, the basis that grounds teleological explanation cannot be the active role of final/formal causes in generation processes. If, on the other hand, vital heat cannot sufficiently account for generation because it is dependent on the direct involvement of formal/final causes then this activity of the form is what grounds teleological explanation.

organism, and so on. So there seems to be no absolute dividing line, or at least Aristotle does not seem to press for one, in relation to what constitutes part of the substantial nature of living things. The explanations Aristotle offers tend to run from some basic activities to the formation of parts, anhomeomerous for the most part, for these activities. The latter may constitute the ground for explaining further auxiliary activities and parts, which in their turn may be explanatory for further changes or the formation of further parts. The whole explanatory process is constrained by material factors. But this is not to deny, first, that there is a structure of explanation such that some of the changes a living thing undergoes are prior, ontologically and explanatorily, to further changes; nor that there is a basic ontological and explanatory level grounding explanation. This seems to be required if the natures of living things have to be some sort of unity.[24] As argued by Broadie, there must be one defining activity or change of the nature of living things which stands to other specific unenforced, i.e. natural changes they undergo as *behavioural form* to *behavioural matter* being realized through them.[25] The activity that provides the grounds for such a unity of the natural changes a living thing undergoes, is, I believe, its reproductive/nutritive capacity. The possession of this soul-faculty by living things is what ultimately explains the behavior

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[23] As opposed to cases of unnatural or spontaneous generation. The latter cases of generation are discussed in *Appendix III*. I argue that both accounts offer evidence against a reduction of the potential for form to a 'program'-like activity such as the one attributed by some to vital heat.

[24] The rationale here follows Broadie's argument that it must be only some of the natural (unenforced) changes a living thing undergoes that constitute the core substantial nature of that living thing: 'It is not enough to say that the substance is of a sort to do if unhindered A under conditions X, B under conditions Y, etc., for to say that it is *a sort* at all already implies some underlying or overall unity of nature, which can be expressed only in a corresponding unity of behaviour, and this is not brought out by such a list of hypothetical behavings.' (1982a:241) According to Broadie there must be a single description under which all the above changes can be subsumed, which she identifies with the maintenance of the life-form of which an individual is an instance.

[25] Broadie offers this analysis in a different context, in order to show the applicability of the agent-patient model in the case of the changes suffered by individual substances such as living things: 'in view of this distinction between the two aspects [i.e. the generic or causally basic and the specific or caused one] of any concrete stretch of unenforced behaviour and of the causal relation between them it is perhaps not unreasonable to apply the terms 'agent' and 'patient' to the same organic individual. According to this analysis, it is not the *physical matter* of the organism (e.g. the earth of which it is composed) that is the patient of self-change, but the *organism itself regarded as the subject of those unenforced changes that stand to the life-activity as behavioural matter to behavioural form.*' (1982a:241-2)

of individual living things as teleologically functioning systems. This leads to the final question concerning the relation between two forms of teleology in Aristotle, namely generation and function.

This difficulty is addressed in chapter 9. It also constitutes the third question that arises from the close association of generation with nutrition, namely to what extent the biological passages warrant or pose difficulties for this identity between generative and nutritive soul. The activity of the form of a natural kind aims at continuing its persistence in a state of full actuality. This end depends on the reproductive capacities attributed to the form of the kind and particularly to the generative part of the soul, since the generative capacities constitute an active efficient cause in generation. But now the generative, persistence-generating, capacity of living things is closely related to the nutritive capacity responsible for their development and self-maintenance. So the activity of the generative/nutritive capacity and what it produces must also be directed towards enhancing the persistence of the organism. Hence it must create the organs that are necessary for the functions necessary for this persistence and it also must support the maintenance of those functions. This suggests that the generative/nutritive faculty of living things grounds teleology on two different but closely related areas of the life of organisms. In other words there seems to be a natural progression between the two areas to which teleology applies, reproduction and function. The close association between generative and nutritive faculty can be understood as that which binds together the two levels of teleology.

1. Introduction

The distinction between what is part of the essence of an entity and what is not can be illuminated by the study of a number of points explored in the logical works, especially in the *Analytics*, but also in the *Topics*.

Although, the *Topics'* aim is not a full account of scientific definition, or the spelling out of criteria for such definitions, the remarks made there are suggestive of a number of points that are present in the *Analytics*. Secondly, these points are compatible with the method displayed in the biological studies, although they are elaborated and specified further. So an examination of the relevant passages can shed some light on the questions concerning the definitory or essential properties of natural kinds. These points have not received particular attention in connection to the *Analytics* or to the biological works.

By contrast, the comparison of the method of scientific explanation and definition laid out in the *Analytics* with the method followed in the biological works has received much attention in recent literature. In particular the compatibility between the *Analytics'* scientific model, or ideal, and the method exposed in *PA* I as well as the actual practice displayed in the biological studies has been the object of much discussion, which focuses on at least three general questions: is Aristotle's biological practice compatible with (a) an axiomatic structure of a scientific discipline, and (b) with the central role played by demonstration; finally (c) what is the relation between the rules of definition by division and the rules of explanatory definition.

In the following chapters, 2-3, I want first to examine some of the ideas exposed in the *Topics* that concern definition and focus on some features that are further explored in the *Analytics*. Then I will turn, ch. 4-5, to the *Analytics'* account of definition, and I will focus on elements concerning (c) above. In the course of this discussion I will consider some issues concerning (b). I will have something to say about (a) in the second part of the dissertation.

2. Kinds of predication in the *Topics* and definition

The *Topics* deals mainly with the examination of a number of *topoi* that are useful in dialectical argumentation. The exposition of the useful *topoi* is preceded by a discussion of the different kinds of predicables that constitute the subject of these dialectical exchanges. Definition and its parts, genera and differentia*e*, are put forward as two of these categories of predicables. An important device or criterion delineating them from other kinds of predicable entities is what Aristotle labels 'predication in the what-it-is of a subject'. This is a key concept for understanding the *Topics'* take on matters concerning definition and essence.

In *Topics* I Aristotle divides predicates that are truly predicated of a subject into four kinds: (a) definitions, (b) unique properties, (c) parts of definitions and (d) accidents (*Topics* I.4-5, 8). These four kinds of predicables are distinguished by reference to the kind of relation that holds between the predicate and the subject in a given proposition. (Frede [1987:32]) Apart from this horizontal division of the predicables, Aristotle introduces, in *Top.* I.9, an independent division that cuts across the previous one. The opening lines of chapter 9 (103b20-21) read thus: 'we must distinguish between the genera of κατηγορίαι in which the four above-mentioned [predications][26] are found.' There is disagreement concerning the understanding of the first occurrence of κατηγορία in the sentence. Does it refer to genera of predicates or genera of predications?[27]

According to one interpretation 'genera of predicates' in the above passage refers to a division of metaphysical categories. This line reads the whole of chapter 9 as evidence for

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[26] For the second occurrence of 'predication' in the above passage see Frede (1987:33).

[27] The translation of κατηγορία in the first sentence poses the first dilemma, for it can be taken as referring to predicates or kind of predicates, or as predications/kinds of predication. The former translation implies that Aristotle introduces here a list of classes of predicates. Frede examines the occurrences of κατηγορία in the *Topics* (107a3; 109b5; 141a4; 152a38; 178a5; 181b27) and argues in favour of rendering it as predication/kind of predication. In what follows I subscribe to this line, advanced also by Morrison. (1994)

the standard Aristotelian doctrine, introduced in the *Categories*,[28] that items in the ontology fall under one of the following ultimate genera: substance, quantity, quality, relation, place, time, position, state, activity and passivity. Indeed, in *Topics* I.9 103b22-3 Aristotle refers to all but one of the above categories. The only exception is that 'substance' which appears in the *Categories'* list, is here substituted by the expression 'what-it-is'. So, according to this line that reads the ten metaphysical categories in the *Topics'* passage the expression 'what-it-is' here is a variant for the term 'substance'.

However, this interpretation is not confirmed by what comes next. Aristotle's illustrations for the first category, the category of the what-it-is, includes items that do not fall under the metaphysical category of substance introduced in the *Categories*. Aristotle says that when we say of the whiteness of an entity that it is white or that it is a color we state what the thing before us is, namely that it is a quality of this sort. (103b31-3) By this he means that the predicative relation expresses an essential characteristic of a subject quality. Both the subject, i.e. the particular color before us, and the predicates 'color' and 'white' signify items that in the *Categories* list will be classified as qualities. Nevertheless, the predication relation reveals what the subject entity is, namely what kind of thing this particular color is. Hence, the category of the what-it-is refers to a predicative relation between subject and predicate, i.e. it designates a certain kind of predication. In that respect, it cannot be a variant for the metaphysical category of substance, at least in *Top.* I.9. It rather points to a predicative relation between subject and predicate, such that the predicate signifies what the subject is, i.e. it says something concerning the nature of that subject. This suggests that the ten categories introduced at 103b20 and referred to at b25 do not stand for classes of predicates but for predicative relations.

Apart from this technical use of κατηγορία, meaning kinds of predication, there is yet another occurrence of the term in I.9: 'It is clear too, on the face of it, that the man who

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[28] See *Cat.* 4 1b25-7; *APo.*. I.22 83a21, b16; *Met.* V.2 1026a36; V. 4 1029b4.

signifies what something is signifies sometimes a substance, sometimes a quality, sometimes some one of the other κατηγορίαι.' (103b27-29) Frede argues that the plural κατηγορίαι here refers not to kinds of predication, but rather to kinds of predicates derived from the corresponding kinds of predication.[29] Thus where a predication relation reveals a quality of a subject, a predicate can be derived from it which would be classified under the corresponding category of predicates.[30] Relying on these occurrences of the word κατηγορία Frede distinguishes between '(a) categories in the sense of kinds of predication, (b) classes of predicates, [i.e. linguistic items] defined by the kinds of predication in question, and (c) the ultimate genera of what there is,' i.e. entities or beings. (1987:35)

On this interpretation, when Aristotle says that by signifying the what-it-is one signifies either a substance or a quality etc. he means that by a predicative relation of the first kind of predication, i.e. (a) above, it is possible to signify different types of predicates under (b). That κατηγορίαι in l. 29 should be translated as 'type of predicates' follows from the fact that the term refers to a division within a certain kind or type of predication, namely within the first kind of predication. Given relations in the first category of predication, i.e. in the what-it-is, and given that the predications reveal the *what-it-is* of different kinds of subjects it follows that different types of predicates are demarcated by means of this type of predication. If κατηγορίαι here is understood as 'types of predicates', then Aristotle distinguishes here between types of predicates within the first category of predication. Predication in the what-it-is produces a division into types of predicates depending on

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[29] Although the term in its technical sense applies to kinds of predication, here, according to Frede, it is used by extension for the classes of predicates that are defined by means of the kinds of predication: 'To understand this use we have to keep in mind that the kinds of predication define classes or kinds of predicates, namely the classes of those predicates which occur in a statement of a given kind of predication, the category of quality, e.g., defines the class of predicates called qualities, the category of quantity the class of quantities.' (1987:35)

[30] Frede offers the following example illustrating the distinction between kinds of predications and kinds of predicates. The qualitative predication 'being healthy' gives rise to the corresponding quality predicate 'health'. 'Being healthy' falls under the kind of predication relations that reveal a quality of their subject. The quality 'health' is something different and falls under a kind of predicates, namely the kind of predicates that is defined by means of the corresponding kind of predication.

whether the proposition formed by means of the predication states the what-it-is for a substance, a quantity, a quality etc. This is also suggested by the illustrations:

> For when a man is set before him and he says that what is set there is a man or an animal, he states what-it-is and signifies a substance; but when a white color is set before him and he says that what is set there is a white or a color, he says what-it-is and signifies a quality. Likewise, also if a magnitude of a cubit be set before him and he says that what is set there is a cubit or a magnitude, he will be describing what-it-is and signifying a quantity. (*Top.* I.9 103b29-35; Smith's tr.)

The examples are cases where a property is truly predicated of a subject in the sense that it says what the subject is, i.e. it says something about the subject's nature. Depending on this nature a predicate can be derived from the predicative relation, falling under one of the κατηγορίαι of line b29. These predicate expressions may signify either a substance or a quantity, or a quality and so on. So items that fall under kinds of predicate expressions (i.e. (b) in Frede's schema above) should not be confused with the items that come under the metaphysical categories (namely (c) in Frede's scheme). The former is a classification of predicate expressions while the latter is a classification of items in the ontology.[31] Thus the first category of predication includes predicative relations where the predicate signifies an essential characteristic of the subject, independently of whether the predicate signifies a substance, a quality or a quantity, i.e. independently of the metaphysical category under which what is signified by the predicate falls. Therefore, neither the first figure of predication nor the kind of predicates defined by means of this predicative relation should be confused with the metaphysical category of substance.

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[31] There are two differences between the two classificatory schemes according to Frede. First when the first class of predicates, i.e. the class of predicates defined by the first category of predication, is compared and the first class of entities, i.e. substances, it becomes evident that 'the first class of predicates contains not only substance-predicates, but also quantities, and all other kinds of entities, all entities one could refer in an answer to the question what something is essentially, whether that something be a substance, a quality, or a quantity.' The second difference is that 'the first class of predicates will only contain predicates and not individuals, whereas the class of substances will contain individual substances, if anything.' (1987:36) This difference is not immediately relevant to the present discussion.

Moreover, there is the following asymmetry between the two classificatory schemes. In the case of the metaphysical categories each entity falls under just one metaphysical category. In the case of kinds of predicates, on the other hand, a predicate may fall under more than one category depending on whether it is predicated of different subjects in different figures of predication. The predicate 'white', for instance, signifies an entity that belongs to the metaphysical category of quality. This fact does not determine the predicative relation between the predicate and the entities qualified by it. When 'white' is truly predicated of 'Socrates' it signifies a quality of the subject, and it is predicated of it under the corresponding figure of predication. When 'white' is predicated of this particular color it signifies what something essentially is and it is predicated in the first figure of predication. This is confirmed by the concluding remarks of *Top.* I.9:

> ...each of these kinds of predicate, if either it be asserted of itself, or its genus be asserted of it, signifies what something is; if on the other hand, one kind of predicate is asserted of another kind, it does not signify what something is, but a quantity or a quality or one of the other kinds of κατηγορίαι (103b35-8, Smith's tr.)

The first sentence refers to the first category of predication, while the following one to further categories of predication. The latter are introduced by predicative relations involving different types of predicates. We are told that if one type of predicate is asserted of another the κατηγορία, i.e. their relation, falls under a kind of κατηγορία other than the first. So Aristotle contrasts two types of cases. First, for any two predicates, *p1*, *p2*, related so that *p1* is truly predicated of *p2* as a subject in the first category of predication, *p1* and *p2*, fall under the same kind of predicates. Second, if a predicate, *p3*, falling under a category of predicates other than the one *p1*and *p2*, fall under, is truly predicated of either *p1* or *p2*, the predicative relation will fall under a category of predication other than the first. For *p3* does not express what the subject is but it qualifies the subject in a certain way. It seems that in this second case what is primitive is not the kind of predication a predicative relation falls under, but rather the kind of predicates the predicate expression falls under. However, this holds only

in this second kind of cases, i.e. in predicative relations that are not of the first kind. For this is the scope of the remark. So predicative relations under the first figure of predication seem to be the basis for deriving both the kinds of predicates and other figures of predication.

The above remarks offer at least a speculative answer to the question how the classification into kinds of predications forms the basis of a division into kinds of predicates. It seems that predication in the first figure is a primitive notion from which the different types of predicates as well as the other categories of predication are derived. All first figure predications are predicative relations between items within the same category of predicates, i.e. intra-categorical predications. If one collects the predicates truly predicated of a subject in the first figure, one can determine what are the other kinds of predicative relations by means of observing inter-categorical relations between the above kinds of predicates. Although this is speculative, since the text does not offer us clear indications of the construction of the corresponding classifications and the necessary criteria, it displays the centrality of the first category of predication in sustaining the classification.

What intuitions can account for this central role of the first figure? The following thoughts, although tentative, at least suggest that these intuitions may have a plausible basis. If we take as an example the predicate expressions 'color' or 'white' when truly predicated of 'Socrates' or 'Boucephalus' they do not signify what their subject is (but rather a quality the subjects possess). On the other hand 'color' is related to 'white' in a different way. The subject term of the predication, 'white', is itself a predicate-expression that has the same function as the predicate, 'color', when it is predicated of items under different kinds of predicate expressions, e.g. substances. 'White' and 'color' qualify their subjects in the sense that they answer the question of what quality the subject is. If, for instance, 'white' is truly predicated of 'Socrates' then what makes true the predication is that white qualifies Socrates as a white thing, it determines that Socrates is white. Hence, what is determinate about white is how it can qualify a given subject. This determination is what provides identity criteria for the quality that the predicate 'white' signifies. If so then white cannot be subject to a

qualification in the same way as Socrates is. When color is predicated of white, the predication does not add a qualitative determination to white in the same way that white, or white-ness, adds a qualitative determination when it is predicated of Socrates. For white, or white-ness, already possesses the property of being a color as a determining feature of its identity. So the predicative relation between any two entities under the same category of predicates reveals something about the nature of the subject. Similarly, the corresponding predicative relation between two predicate-expressions which are found under the same category signifies something about the nature of the subject because it signifies what the subject in question is.[32]

The kinds of predicate-expressions are derived from a corresponding number of determinate predicative relations that predicate-expressions bear to their subjects. They qualify their subject in one of the ways that correspond to a figure of predication. However, when they are predicated of a predicate-expression that enters into the same kind of predicative relations they signify what the subject-expression is, or signifies. These are cases of predicative relations under the first figure of predication. The relation between subject and predicate signifies a determining feature of the subject, a feature that is marking the nature of that subject. By contrast, predicates that are predicated in the other categories of predication do not signify a determining feature of the nature of that subject.

3. What predicables are predicated in the first figure of predication

The first category of predication contains predicates that fall under different kinds of predicates, i.e. substance, quality, quantity etc. Those types of predicates are also divided horizontally according to the division of the four predicables introduced in *Topics* I.4-5. The

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[32] When a predicate-quality is predicated of a subject-quality, either (a) the predicate signifies a qualitative characteristic which is different from what the subject is, or (b) it signifies a qualitative characteristic that the subject quality possesses as one of the determining features of its identity. Now what is determinate about a quality is the set of qualitative features that make up this quality. So if (a) were the case this would alter the subject quality into a different one. Predication in the what-it-is should be understood along the line suggested by (b) above, namely that when a predicate that

predicables are divided into definitions, *propria*, genera and accidents. Predicables that are predicated in the first figure of predication include definitions, genera, genus-like entities and the names of the subject entities. (103b37-8) The remaining two kinds of predicables, accidents and *propria*, on the other hand, are always predicated in figures of predication other than the first.

Aristotle introduces definitions and *propria* under the common label ἴδια, unique properties in the broad sense. Then he divides this latter class into (a) definitions and (b) *propria*, unique properties in the narrow sense. The distinction is spelled out in terms of the criterion of whether a predicate is predicated in the first figure of predication. Definitions are predicated of a subject in the category of the what-it-is, i.e. they signify what kind of thing the subject is. *Propria*, on the other hand, do not signify what kind of thing the subject is but merely a necessary property of that subject. (*Top.* 1.4 101b20-1; 103b9-10) Thus only a sub-set of the necessary predicates of a subject constitutes the essential predicates of that subject, namely those predicated in the first figure.

What sustains the distinction between different kinds of necessary predicates of a subject relies on intuitions concerning the figure of predication in which a predicate is predicated of that subject. Necessary predicates predicated in the first figure of predication signify essential properties of the subject while necessary predicates predicated in any other figure of predication signify necessary non-essential properties of that subject.[33] So a first approximation of what kind of items *propria* are, is the following one:

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expresses a quality is truly predicated of a subject that also expresses a quality the predicate reveals a determining characteristic of the identity of the subject.

[33] This contrasts Aristotle's distinction between essential and non-essential properties to the way the distinction is drawn in contemporary essentialist accounts where essential properties are standardly all and only the necessary properties of a subject. One way this intuition is cashed out is the following: x exhibits a property, P, essentially just in case x exhibits P in the actual world and in every possible world in which x exists, and x exhibits P merely contingently just in case x exhibits P in the actual worlds, but there is at least one possible world, W, such that x exists in W and fails to exhibit P in W.

(1) A property, *p1*, predicated of a subject, *s*, is a *proprium*, a unique property in the narrow sense, of *s* just in case it is (a) a necessary property of *s*, and (b) it is predicated of it in a category of predication other than the first.[34]

However, Aristotle claims something stronger than (a). *Propria* are not merely necessary properties of their subject, they also counter-predicate with it where counter-predication is illustrated thus: 'if something is human, then it is capable of becoming literate, and if it is capable of becoming literate then it is human.' (102a20-22) The relation can be understood in terms of co-extension:

(PCP) A term *A* counterpredicates with a term *B*, if *A* is predicated of *B* and whatever is *A* is *B*.

This is just a sufficient condition for *propria*, since definitions are also co-extensive[35] with their subjects.[36] So the above definition of *propria* can be reformulated thus:

(1*) A property, *p1*, predicated of a subject, *s*, is a *proprium* of *s* just in case it is (a) a necessary property of *s*, and (b) it is predicated of it in some category other than the category of the what it is, and (c) counter-predicates with *s*.

The corresponding definition of the predicables which are definitions will be:

(2) a formula, *f1*, predicated of a subject, *s*, is the definition of *s* just in case it (a) counter-predicates with *s*, and (b) it is predicated of it in the category of the what-it-is.

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[34] See also Brunschwig (1967:XLVII). Verbeke claims that although a *proprium* does not express the essence of its subject it is derived from some essential characteristic of that subject. (1968:260)

[35] Some qualification needs to be added. The point cannot be that unique properties (in the broad sense) are strictly speaking co-extensive with their subject, strictly speaking. Some definitions properties do not, strictly speaking, hold of every subject. Not every man is a biped terrestrial animal. Some are impaired. The same might be true of some *propria*.

[36] Smith objects that if Aristotle intends to define broad unique properties as follows: '*A* is a (broad) unique property = *A* counterpredicates with B', unexpected consequences follow. His argument has the following structure: [1] Counterpredication is symmetrical: if *A* counterpredicates with *B*, then *B* counterpredicates with *A*. Suppose now that, [2] *A* is the definition of *B*; then [3] (by the definition of broad unique property and 2)] A counterpredicates with *B*, and [4] (from 1 and 3)] *B* counterpredicates with *A*, and therefore [5] (by the definition and 3,4) *B* is a unique property of *A*. Moreover, if we assume that [6] 'definition of' is asymmetric, [7] (by the definition 1 and 6)] any definiendum is a unique property in the narrow sense of its definiens, since it cannot be its definition.

Unique properties (in the broad sense) are divided into those that signify the what-it-is-to-be something, i.e. definitions, and those that do not, i.e. *propria* (*Top.* I.4 101b20-1). This seems to block [7] above, however the absurdity remains. What this shows according to Smith is that being a unique property cannot be simply a matter of co-extension: 'he thinks of the four predicables as possible relations between predicate and subject, and he does not generally think of the relation of predication as symmetrical. In order for *A* to be a unique property of *B*, it must be predicated of *B*.' (1997:61-2) If the latter condition is correct then an entity *A* is counterpredicated of *B*, just in case it is predicated of *B* and what *B* is predicated of and nothing else.

Apart from definitions, genera as well are predicated in the what-is-it of their subjects, and the same holds for genus-like entities where these most probably include differentiae. Genus is defined as that which is predicated in the what-it-is of many things which are different in species. (*Top.* I.5 102a31-2) Thus generic predicates do not belong exclusively to any one of the subjects they are predicated of (i.e. they are not unique properties of those subjects). They are necessary and essential properties of their subjects that do not counter-predicate with them. For instance, for a genus *G* and for any species *S* that falls under *G*, it does not follow that if something is *G*, then it is *S*. By contrast definitions uniquely identify their subjects.

4. A complication with *differentiae*

The case for differentiae, however, is more complicated. There might be differentiae that belong to just one species. Such differentiae would be predicated of all and only the subjects that belong to that species and thus they would be co-extensive and counter-predicate with it. If, in addition, differentiae are predicated of their subject in the first figure of predication, then at least some differentiae satisfy the two criteria for definitions.[37]

Assuming that the two conditions in (2) above, (a) and (b), are Aristotle's criteria for definitions, there are at least two options here, namely, to show that differentiae do not satisfy either (a) or (b). The latter alternative seems plausible for differentiae, in some passages, e.g. *Top.* IV.6 144a17-22, are said to be qualities. This gives reason to doubt that they are predicated of their subject in the first figure of predication (at least where their subject is not a quality). If so they do not satisfy (b), and thus the problem of conflating differentiae and definitions is avoided.

However, if differentiae do not satisfy (b) a similar problem arises. For if differentia*e* are predicated of their subject in figures of predication other than the first, and some of them

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[37] For some differentiae by counter-predicating with their subject satisfy (a), while all differentiae are predicated in the what-it-is of their subject, and thus satisfy (b).

counter-predicate with their subject, then some differentiae satisfy the two criteria for *propria*. Therefore it seems that the proposed criteria for definitions and *propria*, entail the following dilemma with regard to the status of differentiae. Either differentiae are predicated in the first figure of predication and some differentiae will satisfy the criteria for definitions, or differentiae are predicated of their subject in a figure of predication other than the first, and some differentiae will satisfy the criteria for *propria*. This suggests that the rejection of criterion (b), predication in the what-it-is, does not solve the problem concerning the sufficiency condition for differentiae. So let us consider the rejection of criterion (a), counter-predication.

First, no statement in *Topics* I implies that differentiae counter-predicate with their subject. Further, there is no indication that Aristotle considers the above dilemma concerning the conflation between differentiae and *propria* or between differentiae definitions. This implicitly suggests that Aristotle does not consider the claim that some differentiae counter-predicate with their subject. So there is no evidence at least in *Topics* I that differentiae satisfy (a), although some evidence for the claim that some differentiae belong exclusively to their subject can be gathered from elsewhere.[38] But even this would not entail that differentiae counter-predicate with their subject in a sense that would conflate them either with *propria* or definitions for the following reason.

Aristotle distinguishes between an absolute and a relative or qualified way of belonging exclusively to a subject. (*Top.* V.1 128a45-7; 128b5-8) The unqualified way may imply counter-predication and thus include the way *propria* belong to their subject. Differentiae, on the other hand, seem to belong exclusively to their subject in the qualified or relative way which does not imply counterpredication.[39] The relative way applies to attributes that belong

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[38] E.g. from the account given in *Met.* VII.12 1038a19-20.

[39] Strictly speaking Aristotle distinguishes between an absolute and a relative sense of being a *proprium*. However, his examples for the relative sense refer to differentiae. So whatever the exact contrast the distinction is applied in such a way that the differentiae belong exclusively to their subject in the relative sense. (See also Verbeke (1968:261))

exclusively to a subject either at a given time or as compared to some other subject(s). For instance, the property 'biped' belongs exclusively to man only when the subject is contrasted with quadruped animals such as horse and dog. (*Top.* V.1 128b5-8) So it belongs exclusively to that subject in the relative sense, and thus, strictly speaking, it does not counterpredicate with it.[40]

This may not offer conclusive evidence that Aristotle holds that differentia*e* cannot counter-predicate with their subject. It shows, however, that belonging exclusively to a subject does not entail counter-predication, and hence it suggests the plausibility of the claim that differentiae do not counter-predicate with their subject even though they might uniquely identify a subject within the limits of the genus. If it is plausible to assume that differentiae do not counter-predicate with their subjects, then it is possible to hold that differentia*e* are predicated of their subject in the first figure of predication without conflating them with definitions. So let us turn to the claim that differentiae are predicated in the what-it-is of their subject.

5. Being predicated in the 'what-it-is' and the parts of the definition

Aristotle gives two independent criteria that divide definitions, genera and genus-like entities or differentiae (from then on definitory predicables), from the other predicables, i.e. *propria* and accidents: (a) the criterion of whether a predicable is predicated in the what-it-is, and (b) the criterion of whether the predicables are definitions or parts of definitions. The latter criterion is used in the deduction of the four predicables in *Top.* I.8, while the former is used in the definition of the predicables in *Top.* I.4-5. (101b20 ff., 101a37, 102a31-b3) The compatibility of the two divisions of the predicables has been questioned and this turns, partly, on the compatibility of the two criteria. Do they yield identical results and are they equivalent?

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[40] *Propria*, on the other hand, belong exclusively to their subject in the absolute and thus counterpredicate, strictly, with their subject. (*Top.* I.5 102a18-30).

The reason for questioning the equivalence of the two criteria relates to the ontological status of differentiae. For although differentiae are clearly parts of definitions it is not clear whether they are predicable in the what-it-is of their subjects. Indeed Aristotle claims that differentiae are qualities (e.g. *Top.* VI.6 144a17-22) and not substances (*Cat.* 3a21 ff.). If differentiae fall under the category of quality they cannot be predicated in the what-it-is of subjects that fall under categories of predicates other than quality. So if the predicables are divided according to the criterion of predication in the what-it-is there is a contrast between differentiae on the one hand and genera and definitions on the other. However, when the predicables are divided according to the criterion of whether they are definitions or parts thereof, differentiae are ranked together with definitions and genera. Therefore, it appears that there is a discrepancy between the two divisions.

This tension can be questioned in the following respect. First, the claim that differentiae cannot be predicated in the what-it-is fails to do justice to the distinction between metaphysical categories and categories of predication. According to *Topics* I.9 being predicated in the what-it-is signifies the first category of predication. The fact that the relation between a predicate and a subject falls under the first category of predication is not the only factor that determines the metaphysical category under which the entities that the subject and the predicate signify fall. The *Topics* and *Categories* passages that refer to differentiae as qualities can be read as referring to their metaphysical status. And this does not determine the figure of predication according to which they are predicated of their subject.

Secondly, if differentiae are signified by predicates that fall under the category of quality, then, when predicated of a subject falling under a different category of predicates, say substance, the predicative relation would not fall under the first figure of predication, and as a consequence the differentia would not be predicated of the subject synonymously, i.e. its definition would not be predicated of that subject. Nevertheless, both in the *Categories* and the *Topics* Aristotle allows that differentiae are predicated of subjects in the category of

substance synonymously. (3b1-2; b5-9) Hence, even though differentiae are said to be qualities, this must be compatible with the differentiae being predicated synonymously of their subject and thus in the first figure of predication.[41] So independently of the fact that differentiae-predicates signify items that fall under the metaphysical category of quality, they are predicated of their subjects in the first figure of predication. This blocks the objection from the claim that differentiae are qualities.[42]

So let us look at the compatibility of the two criteria. The division of the predicables that makes use of the former criterion yields, according to Smith, the following definition of the parts of definitions, i.e. of genera and differentiae:

A is genus or differentia of *B* = [1] *A* is predicated of *B* and [2] *A* does not counterpredicate with *B* and [3] *A* is in the definition of *B*. [Smith (1997:73)]

Smith points to two problems with this definition. First, although the conjunction of [1] and [2] may be thought of as equivalent to 'predicated of many things' which appears in the definition of genus at 102a31-2, the application of the definition to differentiae ignores the fact that 'differentiae are usually, if not always, counter-predicated of their species.'[43] It seems possible that a specific differentia can counter-predicate with its subject and we saw that this may be a threat to the division of the predicables. For if differentiae counter-predicate with their subject they may be conflated either with definitions or with *propria*.

However, a predicable counter-predicates with its subject if and only if it uniquely identifies this subject. As it was argued above Aristotle distinguishes between an absolute and a relative sense of uniquely identifying a subject. (*Top.* V.1 128a45-7, 128b5-8)

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[41] If this is denied then one has to accept that there are inter-categorical predicative relations according to which the predicate is synonymously predicated of its subject.

[42] If so the metaphysical category under which differentiae fall does not offer an argument against the equivalence of the two criteria used in *Topics* I for dividing the four predicables, predication in the what-it-is and being a definitory predicate.

[43] Smith (1997:73). There is a vast number of differentia*e* that cannot counterpredicate with the species. For instance, differentiae that belong to two (or more) genera neither of which contains the other, such as the genus terrestrial and winged to which the differentia biped belongs. Thus biped is wider than any species of terrestrial or any species of winged animals (*Top.* VI.6 144b20ff.). and cannot counterpredicate with the species man because it has a wider denotation than that species.

Differentiae belong uniquely to their subjects in the qualified sense.[44] And the qualified sense does not entail counterpredication. Let us look at a relevant passage where Aristotle examines the apparent absurdity that results from predicating the differentia of the definition:

> ...man is a biped; therefore what is the same as man is a biped; but a terrestrial biped animal is the same as man, therefore a terrestrial biped animal is a biped. But this is not absurd. For *biped* is not predicated of terrestrial animal (if it were then we should certainly have biped predicated twice of the same thing); but the subject said to be a biped is a terrestrial biped animal, so that *biped* is only predicated once... Absurdity results, not when the same word is uttered twice, but when the same thing is more than once predicated of a subject. (VI.3 140b32-141a1)

'Biped' is predicated of the whole definition, i.e. of 'biped terrestrial animal', and again 'biped' as a part of the definition is predicated of the genus animal. So we have two occurrences only one of which counter-predicates with the species. One way to understand the difference is the following. The expression 'the biped', with the definitive article, is not an adjective but rather functions as a noun. It can take as a complement a generic word like 'thing', 'entity' etc. This construction might be reflecting the fact that in this case the differentia signifies a kind of entity. It is a sortal that carries with it the genus, and not merely a modifier or quality of that genus. By contrast, the second occurrence of 'biped', within the definition, qualifies the genus by being predicated of it under the category of predication quality. If this is the difference, then differentia has a double function: (a) as a part of the definition it does not counter-predicate with the *definiendum*, it is an adjective that qualifies the genus, while (b) as a noun it is predicated of the species in exactly the same manner in which the genus is predicated of the species, i.e. in the first category of predication. For it signifies an essential characteristic of the defined entity, and it presupposes a generic element as a complement. So in this latter sense differentiae are truly predicated in the what-it-is of a subject.

However, to the extent that the differentia carries with it the appropriate genus (*Top.* VI.6 144b26-7) it seems legitimate to claim that it counterpredicates with the species.

[44] This ambiguity allows for two possibilities. Either (a) absolute and relative unique properties counter-predicate with their subject in different ways, or (b) only unique properties in the absolute sense counter-predicate with their subject, while relative ones do not.

A different, though not incompatible, possibility is that differentia*e* do not strictly speaking counter-predicate or uniquely belong, because they are predicated of different species under contrary sub-genera of the same higher genus. E.g. 'biped' is predicated of species of winged and of species of terrestrial animals. Hence, although 'biped' can be thought of as counter-predicating with a species of terrestrial animals that are biped, humans, strictly speaking it does not because it does not uniquely identify this species. It uniquely identifies the species of humans only in the relative sense, i.e. when contrasted to other species of terrestrial animals.[45] So the differentia counterpredicates with its subject only in some qualified sense within the limits of the sub-kind of terrestrial animals. So it does not counterpredicate with the subject in the way definitions or *propria* do, because it belongs to different species across different sub-kinds of the same higher genus.

Therefore, Smith's objection to the above definition of genus and genus-like entities can be met. Differentiae do not strictly speaking counter-predicate with their subject, i.e. not in the way in which unique properties do. If some differentia*e* seem to belong as unique properties to their subject, they do so only in the relative sense. Hence the definition of genera and differentiae, i.e. of definitory predicates, that includes the criterion of non-counterpredication does not exclude differentiae from qualifying along with genera as definitory predicates.

6. *Differentiae* as predicates in the first figure of predication

Let us turn now to the criterion of being predicated in the what-it-is, and see whether it yields similar results to the criterion of being a definitory part.

Some evidence concerning the status of differentiae suggests as we saw that they cannot be predicated in the what-it-is, and this implies a tension between the two criteria. Let us look at the evidence. In laying out the differences between genera and differentia*e*, Aristotle makes the following points: (a) the genus has a wider denotation than the

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[45] *Top.* V.1 129b5-7. Strictly speaking it is the complex predicate 'biped terrestrial animal' that

differentia, (b) in giving what a thing is, it is more fitting to state the genus than the differentia, and (c) the differentia always signifies a quality of the genus, whereas the genus does not do this of the differentia.[46] This passage, and especially (c) is read as advocating the claim that differentiae are not predicated in the what-it-is of their subject. However, criterion (c) claims something concerning the relation between the differentia and the genus it divides and implies nothing about the predication relation between that differentia and its subjects. So the text does not unambiguously justify the step from criterion (c) to the claim that differentiae are not predicated in the what-it-is of the species that are the subjects of these differentiae. Further, none of the criteria draws a direct contrast between genera and differentiae with respect to predication in the what-it-is. To the contrary, criterion (a) presupposes that differentiae are predicated in the what-it-is, and (b), by comparing genus and differentia, assumes that both are predicated in the what-it-is.

Finally, criterion (c) suggests that Aristotle does not detect any tension between the claim, (I) that differentiae are predicated in the what-it-is of their subject which is presupposed by criteria (a) and (b), and the claim (II) that differentiae signify a quality of the genus. In order to get clearer about claim (II) let us consider the illustration of criterion (c): 'the one who says terrestrial he says of what quality the animal is, while the one who says animal he does not say of what quality the terrestrial is.'[47] This statement can be taken as evidence that differentiae are predicated of the species as qualities. However, the example illustrates the claim that a differentia is a quality of the genus while genus is not a quality of the differentia, and not the claim that a differentia is a quality of the species. So the first leg

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counterpredicates with the subject.

[46] *Top.* IV 6 128a10-20. The passage opens thus: 'Since some people think that the differentia, too, is a predicate of the various species in what-it-is, you should distinguish the genus from the differentia by employing the aforementioned principles.' (*Top.* IV 6 128a10-13) Then Aristotle lists again the three main differences between differentiae and genera. He adds that some people think that the differentia is a predicate in the what-it-is. By this he does not necessarily mean to argue against the claim. He rather points to some necessary qualification that must be made before endorsing it.

[47] *Top.* IV.6 128a18-20. Brunschwig's translation of the passage is: "qui dit terrestre, en effet, dit animal qualifié d' une certaine façon; mais qui dit animal ne dit pas terrestre qualifié d' une certaine façon." (1965:*ad.loc.*)

of the example does not entail that differentiae are predicated of the species as qualities, but only that they are predicated of the genus as qualities.

For instance, in the claim 'this animal is terrestrial' the differentia terrestrial qualifies the genus animal. The differentia adds a qualification such that the entities signified by the genus are restricted. By contrast in the claim 'man is terrestrial' the differentia does not qualify the subject in a similar manner. The differentia does not add a qualification such that it restricts what is signified by the subject into a sub-class of the entities signified by it. Rather being terrestrial is something already present in what man is, something that is included in the nature of what is signified by 'man'.[48]

The above example suggests the compatibility between claims (I) and (II) in terms of the proposed interpretation of passage *Top.* VI.3 140b32-141a1, quoted in p. 44 above. The differentia of man, biped, is predicable of the definition of man and at the same time a part of that definition. As part of the definition, biped qualifies the genus and is predicated of it in the figure of predication of quality. When constructed with the definite article functions as a noun predicable of the definition and the *definiendum* in the first figure of predication. So if the subject of which the differentia is predicated is the genus it signifies a quality, while if the subject is the *definiendum* it signifies an essential predicate and is predicated in the what-it-is.

This suffices to establish that the equivalence between the two criteria, namely being predicated in the what-it-is of a subject and being part of the definition of a subject, is not untenable, and that it is not necessary to regard them as yielding conflicting results. This view gets further support from Aristotle's deduction of the four predicables in *Topics* I.8.

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[48] Thus a differentia is said to qualify the genus because it is a predicate categorically lower than it and it divides a sub-class out of that genus. This does not entail that this quality of the genus must be predicated as a quality of the species divided out of the genus. It is still possible to hold that the differentia terrestrial is predicated in the what-it-is of the subject human.

7. The deduction of the predicables in *Topics* I.8

In *Top.* I.8 Aristotle proposes a deduction of the four kinds of predicables that makes use of the criterion of being a definitory predicable. By contrast, the earlier division of the predicables in *Top.* I.5 made use of the criterion of predication in the what-it-is. As we saw, the equivalence between the two criteria is contested and so is the equivalence between the two divisions of the predicables in I.8 and I.5.[49]

One reason for doubting the equivalence is based on the claim that differentiae express qualities (*Top.* IV.2 122b15-6; VI.6 144a20-21) Hence they cannot answer 'what is it?' questions. Genera, on the other hand, are said to be parts of definitions exactly because they appropriately answer 'what is it?' questions. (*Top.* I.5 102a31-2) This is why they are said to be predicated in the first figure of predication. This indicates a difference between 'predicated in the what-it-is of a subject' and 'being part of the definition of a subject'. The latter includes differentiae while the former excludes them. Nevertheless, as we saw above, differentiae are explicitly said to be predicated in the first figure of predication, i.e. in the what-it-is. (*Top.* VII.3 153a17-22; *Cat.* 3a21ff) Further, differentiae are said to be *genus-like* predicables, where this entails being an informative answer to a 'what is it?' question.[50] Finally, as it was argued above, it is possible to consider differentiae as predicable in the what-it-is, even if they fall under the metaphysical category of quality. So the question is why an account of what an entity is must include these two kinds of predicables?

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[49] For instance, Smith claims that the two conditions are not equivalent, and that the sliding from the one condition to the other 'allows Aristotle to make explicit the conception of a definition as composed of genus and differentia, but he does not tell us what the difference between these two is nor explain why a definition must have this form.' (1997:73)

[50] *Top.* I.4 101b18-9. Aristotle does not claim that genera are the only appropriate answers to the 'what it is?' questions, but that they are the most appropriate ones. (*Top.* I.5 102a33-5). This leaves open the possibility that genera are members of a larger class, which includes differentiae. As we saw according to *Top.* VI.3 140b32-141a1 differentiae can be predicated of the definition of the species they belong to. If the 'being predicated of' relation is transitive and definitions are predicated in the what-it-is of the *definiendum*, it follows that differentiae are also predicated in the what-it-is. Hence they can answer 'what is it?' questions, at least in the qualified sense in which they are predicated of the definition.

The beginning of an answer may emerge from a reference to generic or genus-like entities that immediately follows the definition of genus at *Top.* 1.5 102a35-b3. Aristotle says that the question whether one thing is in the same genus as another or not is a 'genus-like' question because in answering that question one uses the same method as when examining what is the genus of an entity. One does that presumably by means of asking the question 'what the thing in question is?'[51] In *Topics* IV Aristotle uses this method in order to illustrate how to spot and avoid specific fallacies when a genus is suggested for a thing in question. (*Top.* VI.1 120b15-6) The method involves the use of differentia*e* and genera. For instance, if a species is placed inside a genus and 'no differentia belonging to the genus is predicated of the given species, neither will be the genus predicated of it [i.e. of the species]', and therefore it can be concluded that the species has been placed under the wrong genus (*Top.* IV.2 123a11-2).[52] Again, in order to examine 'whether the given term fails to be the genus of anything at all... [one should] examine the point by seeing whether the objects that partake of the genus fail to be specifically different from one another.' (IV.6 127a20-25) So establishing the genus involves establishing differences between the entities under that genus. Answering the 'what is it?' question involves locating differentiae that distinguish the subjects of a common genus as subjects of that genus. To the extent that differentia*e* along with genera clarify the what-it-is of the subjects in question, we can think of these two as the only predicates in the what-it-is of a subjects, along with definitions, and as the only parts of these definitions. Now let us turn to the deduction in I.8.

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[51] 'The question whether one thing is in the same genus as another, or in a different one, is also genus-like, since this sort of thing also falls under the same method as a genus: for if we have argued that animal is the genus of man, and also of the ox, then we shall have argued that they are in the same genus, while if we show that it is the genus of one and that it is not the genus of the other then we shall have argued that they are not in the same genus.' (*Top.* I.5 102a35-b3 Smith's tr.)

[52] The use of differentiae is presupposed in *Top.* IV.1 121b15-16. Explicit reference to the use of differentiae while investigating for the genus, and to fallacies that result from misuses of differentiae, is made in VI.2. 122b12ff., 122b18ff., 122b37ff.

The *Topics'* I.8 deduction of the predicables seems to divide predicables exhaustively into four classes or kinds.[53] The deduction proceeds by applying two successive criteria to the whole class thus producing four different classes of predicables: (a) whether a predicable uniquely identifies, i.e. it is co-extensive and thus counter-predicates with, its subject or not, and (b) whether a predicable is predicated of its subject in the first figure, i.e. whether it is an essential predicate of that subject.[54] Criterion (a) divides the predicables into those that are unique properties (in the broad sense), and those that do not uniquely identify their subject, but apply more widely. So this first criterion exhausts the class of predicable items. Then Aristotle applies criterion (b) to the classes obtained from the first division in order to get the fourfold classification of the predicables:[55]

> And if it [i.e. the predicable] does counterpredicate, then it must be a definition or a unique property (for if it signifies what-it-is to be something [i.e. the essence] it is a definition, while if it does not it is a unique property (that is what we said a unique property was, something which counterpredicates but does not signify what-it-is to be). But *if it does not counterpredicate with the subject, then either it is among the things stated in the definition* of the subject or it is not. If it is among the things stated in the definition, then it must be a genus or a differentia, since a definition is composed out of a genus and a differentia. On the other hand if it is not among the things stated in the definition, then it is clear that it must be an accident. (*Top.* I.8 103b12-7, Smith's tr.)

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[53] According to Brunschwig the I.8's function is to justify the affirmation that every premise and every problem has its origin in one of the four predicables, that is to say to guarantee the exhaustive character of their enumeration (1967:XlVII).

[54] Brunschwig (1967:XLVIII).

[55] However, Smith notes: 'What his argument actually establishes is the unexciting result that if *A* is predicated of *B*, then *A* must be the definition of *B*, a unique property of *B*, one of the things in *B*'s definition, or something else.' [Smith (1997:73)]

At least four points need clarification.[56] First, no explicit argument is offered to show that the exclusive disjunction 'things stated in the definition of the subject or not' is indeed the right way to divide the things that do not counterpredicate with their subject, and not an *ad hoc* criterion in order to discriminate between parts of definitions and accidents. Secondly, with respect to differentiae there seem to be no clear indications on why they are included into the category of things that are parts of definitions (apart from the stipulation that a definition is composed out of a genus plus a number of differentiae). Thirdly, the definition of 'accident' here is different from the positive one given in *Top.* I.5, namely (a) an accident is what can possibly belong or not belong to the same subject. An alternative definition is given in I.5, namely (b) accident is what is neither a definition, nor a *proprium*, nor a genus,[57] but Aristotle regards the positive definition in (a) as superior to the negative one in

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[56] These points relate to the controversy over whether the division is exclusive or inclusive. The exclusive interpretation holds that (a) each predicate must belong to one of the four categories and (b) it cannot belong to more than one. The inclusive interpretation holds that, (a*), a predicate may belong to one or more categories just in case it belongs to a sub-category that it is included in some other category, and thus denies (b). (Brunschwig [1967:LXXVI]) According to Brunschwig the claim that *propria* are co-extensive and not essential to their subjects, can be read in the exclusive interpretation as meaning that a *proprium* is a co-extensive, non-essential predicate of its subject, or, according to the inclusive interpretation as meaning that every *proprium* is co-extensive, while not every *proprium* is an essential predicate (Brunschwig [1967:LXXVI]). Brunschwig argues that the central books of the *Topics*, encourage the inclusive interpretation of the division of the four predicables. However he claims that the relevant passages from the first book seem to favour exclusive interpretation. He takes this to indicate that the first book is later, since it is more natural to suppose that one slides from the inclusive to the exclusive interpretation.

[57] The two definitions are given in *Top.* I.5 102b5-7. There is disagreement on whether (a) and (b) are equivalent, and therefore whether the division of the four predicables is exhaustive. The problematic cases are *sumbebekota* that belong to the subject in itself but they are not co-extensive with it (these will include predicates that according to *APo.* I.4 belong *per se* 2 to their subject). They satisfy (b) in that they are neither genera, nor definitions, nor *propria*, but they do not satisfy (a) because they always belong to their subject. Alexander points this. Smith also argues that the two definitions are not equivalent, for there are predicates that are neither definitions nor genera, nor unique properties of their subjects without being true of them contingently. (1997:65-6) His counter-examples are differentiae, and necessary properties such that *A* might be necessarily true of whatever *B* is true of, and of other things as well, without being *B*'s genus. Differentiae can be disregarded as a counter-example if they are genus-like entities predicated in the what-it-is of their subject. The second class of counter-examples could be blocked by the following consideration. A necessary property, *A*, of a subject *B*, that belongs of necessity to subjects, B', B'' etc., which is neither a genus nor a differentia of *B*, *B'*, *B''* etc., it is a unique property of the lower common genus to which *B*, *B'*, *B''* etc. belong. Tierney argues that the two definitions are merely two ways of describing the same thing (2001:6). He is in agreement with Barnes, that the four predicables provide 'an incomplete cataloguing of everything that may be said to belong to something, for it does not... cover those items that belong *in itself*-2 [*per se*-2].' Finally Ebert makes room for *per se*-2 predicates by arguing that an incidental is whatever belongs to something and is such that it may either belong or not belong to

(b). Finally one would expect that Aristotle, instead of using the criterion of whether the predicable is a definitory part or not, would use the criterion concerning predication in the what-it-is. These issues will be addressed as we examine step by step the deduction of the four predicables in *Top.* I.8.

In the first step of the deduction Aristotle divides predicates that counter-predicate with their subject from those that do not. Then the class of the predicables that counterpredicate, i.e. unique properties in the broad sense, is subdivided by applying the criterion of whether a predicable is a definition of its subject or not. So we get predicables that signify definitions and predicables that signify unique properties in the narrow sense. (*Top.* I.8 103b10-11) These two classes were distinguished earlier in terms of whether a unique property is predicated in the what-it-is of its subject or not. So there is some reason to think that the criterion here is equivalent to the one used earlier in I.5 and which will be analysed in I.9.[58] The implicit assumption then is that predicates that counter-predicate with their subject are either: (1) predicated of their subject in the first category of predication, or (2) predicated of their subject in other categories of predication. If condition (1) holds then the predicable is a definition stating the essence of the subject, for it is unique to its subject by signifying what the subject is. If condition (2) holds then the predicable is a *proprium* because it satisfies both criteria for unique properties narrowly construed, i.e. it signifies something unique to the subject without signifying what the subject is.

Then Aristotle turns to the predicables that do not counterpredicate with their subject. Again he does not use the criterion of predication in the first figure: 'if the predicable does not counterpredicate with the subject, then either it is among the things stated in the

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something else. (1998:142 ff.) However, it may be that Aristotle ranks what in *APo.* will come under the heading of per se–2 together with *propria*. For although it is true that those necessary predicates when considered in the context of *APo.* are not, necessarily, co-extensive with the subject they belong *per se*-2, their disjunction is co-extensive with that subject, and they are co-extensive with some narrower subject subsumed under that subject.

[58] Although the deduction of the predicables precedes the introduction of figures of predication in I.9, there is no reason to think that the criteria employed in the latter are not at work here.

definition of the subject or it is not.' How does the disjunction in the consequent follow from the antecedent of the conditional?[59]

One suggestion could be that Aristotle assumes that the predicables that do not counterpredicate can be divided with respect to whether they belong of necessity to their subject (let us call that the *Necessarily Belonging Criterion* (NBC)). This will give us (I) predicates that do not counter-predicate and belong of necessity and (II) predicates that do not counter-predicate and do not belong of necessity to their subject. But is this equivalent to the division we find in the text?[60] On the one hand class (II) may yield exactly the class of accidents. For (II) is equivalent to the positive definition of accidents as the predicables that may or may not belong to their subject.[61] However, (I) is problematic. It yields a wider class than the one we find in the text, i.e. the one that includes only genera and differentiae. Predicables that, according to (I), do not counter-predicate and belong of necessity to their

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[59] Another suggestion is that the following exclusive disjunction underlies the division of the non-counter-predicating predicables: (1) predicables that do not counter-predicate with their subject are either (i) parts of the predicables that counter-predicate with their subject or (ii) not. It seems plausible to assume (i) since some predicables that counter-predicate with their subject, e.g. definitions, are not simple but complex. Definitions are complex formulas composed out of a number of terms, i.e. of further predicables. *Propria* on the other hand seem to be simple predicates and not complex accounts composed out of a number of predicates. It follows that definitions are the only predicables counter-predicating with their subject that have parts. Further it follows that the second disjunct of (1), (ii), is equivalent to the negative definition of accidents, i.e. what is neither a definition nor a *proprium*, nor a genus nor a genus-like entity. For (ii) refers to predicables that do not counter-predicate with their subject, i.e. they are not definitions or *propria*, and are not parts of definitions, i.e. they are not genera or differentiae. This is the negative definition of accidents. But this interpretation is unsatisfactory in two respects. First, the claim that *propria* are not complex is doubtful. Secondly, even if definitions are the only complex predicables it only follows that definitions have parts and not the stronger claim, which Aristotle makes, that the parts of definitions are genera and differentiae. In order to get the latter claim at least two more independent premises are needed: (a) that whatever is predicated in the first figure of predication (and does not counter-predicate with the subject) is part of the definition and (b) that genera and differentiae are the only predicables predicated in the first figure of predication (and do not counter-predicate with their subject).

[60] There is no explicit evidence for a criterion equivalent to (NBC) in the I.8 text. Some implicit support can be gathered from the positive definition of accidents in I.5. For (NBC) is the contradictory of the criterion in this positive definition of accidents.

[61] Note that this does not make the argument circular. Aristotle does not assume the definition of accidents that he is going to prove. The implicit claim on this interpretation is that predicables that do not counterpredicate with their subject, either always belong to their subject or not. Since they are predicables that do not counterpredicate with their subject, this is a legitimate assumption to make and it is an exhaustive disjunction. The fact that the definition of accident, as something that may belong or not belong to one subject at different times, is not put forward by Aristotle here, re-enforces to

subject may include necessary properties that are neither genera nor differentiae. In order to restrict (I) to genera and differentiae there must be some assumption that the only necessary properties that do not counter-predicate are genera and differentiae. And although one may speculate that such a restriction is not totally unjustified there is nothing positive suggesting it in the text.[62] So the disjunction in the antecedent of the conditional cannot be sufficiently justified by an assumption equivalent to NBC.

A more plausible suggestion is that the assumption underlying the conditional relates to the criterion of whether a predicable is predicated of its subject in the first category of predication. As it was suggested above this criterion is at work when predicables that counter-predicate with their subject are divided into definitions and *propria*. So it is reasonable to assume that it is also applied to predicables that do not counter-predicate with their subject. If applied to this class it divides it into two mutually exclusive classes of predicables. In the one class we will get predicables in the first figure, i.e. essential to their subject, which do not counter-predicate with it. As it was argued above, 'being a definitory predicable' is equivalent to 'being predicated in the what-it-is'. So applying the criterion of predication in the first figure to predicates that do not counterpredicate will yield all definitory predicates that are not definitions.[63] These are all and only the parts of definitions, and this is what we have in the first disjunct of the consequent of the conditional. In the other class we will get predicables that are predicated in other figures of predication and thus are not essential to their subjects, and do not counter-predicate with it.[64] These predicates

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some extent the idea that the assumption is at work. Had he defined accidents in this way here, his argument would have been circular.

[62] A similar restriction is implicit in *APo*. II.13 96a24-b14 discussed in ch. 5. It could be argued that necessary predicates that do not counterpredicate with their subject must be either genera or differentiae, on the premise that any other necessary predicate would counter-predicate with a subject higher up, e.g. with the genus. So it would be a *proprium* of the genus.

[63] If 'definitory predicables' and 'predicables in the what-it-is' pick out exactly the same items, definitions and their parts, then if we subtract from this class predicates that counterpredicate with their subject, what remains are the parts of the definition, namely genera and differentiae.

[64] Brunschwig argues (1964:LXXXII) that the negative definition is more valuable when Aristotle wishes to define the four predicables into one system. For if he gives a self-sufficient definition for each one of them their relations would remain obscure. But now there seems to be a

will be non-definitory predicables that do not counter-predicate with their subject, i.e. predicates that are neither definitions, nor parts thereof, nor *propria*. And this is the definition of accidents Aristotle derives in I.8 and the second disjunct of the consequent of the conditional.[65] If so it seems that the criterion relating to figures of predication must be imported to make sense of this conditional. Under this interpretation, the fourfold division of the predicables can be represented in the following way:[66]

Predicables	1. Stating the essence or part of it/ predicated in the 'what-it-is' of their subject.	2. Not stating the essence or part of it/ predicated in the 'what-it-is' of their subject
A. That counter-predicate with their subject	*Definitions*	*Unique properties*
B. That do not counter-predicate with their subject	*Parts of definitions (genera and differentiae)*	*Accidents*

Table 1

8. Why all essential properties are included in the definition

Let us now focus on the parts of definitions, namely on class 2A in the above table. One set of questions, which will be postponed for the next chapter, concerns the evidence for restricting this class to genera and differentiae. A prior question concerns the two conditions that underlie the above division: definitions are composed out of (a) all and only those predicates that are predicated in the what-it-is of a subject which (b) do not counter-predicate

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further reason for sticking with the negative definition. For it seems that Aristotle cannot exclude the possibility that some non-counter-predicating predicates, that are not essential, are necessary to their subject. If the necessity criterion is applied they should be classified together with definitory predicables. If the predication in the what-it-is criterion is applied they should be classified with accidents. Perhaps, facing this dilemma, Aristotle decides to sacrifice the positive definition of accidents, namely that accidents may or may not belong to one subject at different times.

[65] This conclusion does not entail that all accidents are non-necessary predicates of their subject (cf. *A.Po.* where the term 'accident' covers also cases of necessary predicates). It might be argued though that every necessary property is a unique property of at least one of the subjects it is predicated of and counter-predicates with that subject.

[66] Smith offers an alternative representation. He divides predicables into two classes, counterpredicating and non-counterpredicating ones, each one of which is subdivided into two further classes: the first into definitions and *propria*; the second into parts of definitions and accidents.

with that subject. Conditions (a) and (b) are necessary for a predicate to be a definitory part of a subject, while their conjunction is sufficient. The criterion can be formulated thus:

(1) a predicate *p*, predicated of a subject *s*, is a part of the definition of *s*, iff it is predicated of *s* in the what-it-is and does not counterpredicate with *s*.

So the first question is why all and only predicates in the what-it-is are parts of the definition? The definition of a subject signifies what the subject is, i.e. its essence, and Aristotle expresses this idea by using the expression 'τό τί ἦν εἶναι' (101a38).[67] What is stated in the definition of a subject, *s*, is the what-it-is to be *s*. This can be understood in terms of the following conditional:

(2) If a subject is *s*, then it must be the kind of thing specified by a definition, *d*, which is truly predicated (in the first figure of predication) of *s*.

What is specified or determined by means of *d* is that item in the ontology that specifies what kind of thing *s* is. The complex predicate signifying the essence of *s* constitutes the full answer to the 'what is it?' question. So the predication relation between the formula that signifies the essence of a subject and that subject falls under the first category of predication. Since definitory predicates are part of this formula the predicative relation between them and the subject of the definition must also fall under the first figure of predication. However, (1) claims something stronger, namely that all predicates in the first figure of predication are parts of the definition. This idea must rely on the assumption that if the definition of the essence of a subject, *s*, is to offer a complete account of what-it-is to be *s*, it has to include as parts all predicates that reveal something about the nature of *s*. This can be shown in the following way.

It was proposed that the relation between the definition of an essence and the subject to which this essence belongs can be expressed in terms of the conditional: 'if a subject is *s*,

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[67] The expression is often rendered as the 'what-it-is-to-be', but it is standardly taken as referring to what is essential for an item in the ontology if it is to exist as that subject. The expression takes as a complement a noun in the dative case, where the dative refers to the subject of the definition. So a plausible rendering in English is: 'what-it-is to be for *x*', or 'what-it-is for *x* to be.' [Smith (1997:60)]

then it is the kind of thing specified by a definition, d, that is truly predicated of s.' Now, take predicates, p_1, p_2, p_3, predicated truly of a subject, s_1, in the first category of predication, and a definition of the essence of s_1, d_1, which includes or entails p_1 and p_2, but not p_3. According to the conditional, the kind of thing s_1 is must be specifiable in terms of d_1. However, d_1 does not include all predicates truly predicated of s_1 in the first figure, for it does not include p_3. So d_1 fails to account for at least one determining feature of s_1, namely that signified by p_3. Hence, d_1 fails to specify in a complete way what kind of thing s_1 is. This is a reason to deny the consequent of the conditional, namely the claim that 's_1 is the kind of thing specified in d_1.' If the consequent is denied, then, by *modus tollens*, it can be concluded that the subject in question is not, after all, s_1. This contradicts the initial hypothesis. Thus the three following claims form an inconsistent: (i) there is a subject which is s_1 (ii) If a subject is s, then it must be the kind of thing specified by a definition, d, which is truly predicated of s (in the first figure of predication), and (iii) for a subject s_1, and for predicates p_1, p_2, p_3, predicated in the what-it-is of s_1, the definition of s_1, d_1, includes or entails p_1, p_2, but excludes p_3. Which premisse must be rejected is clear. A conditional equivalent to (ii) seems to be something Aristotle endorses in the *Topics*. (i) is a matter of mere stipulation; if it is rejected, then it seems that it would be impossible to identify subjects such as s_1. So the best candidate is (iii), i.e. that there are predicates determining the nature of a subject which are not included in the definition or essence of that subject. (iii) must be substituted by its denial which would be compatible with (ii). The denial of (iii), generalised, is that it is not the case that there are predicates predicated in the what-it-is of a subject which are not included or entailed by the definition of that subject. So predicates predicated in the what-it-is of a subject must be included or entailed by the definition of that subject. This is exactly the first necessary condition for being a part of a definition.[68]

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[68] Here is a slightly different argument. Suppose d_1 is the definition signifying the essence, e_1, of a subject, s_1. If some parts of e_1 cannot be deduced from d_1, either because they are not included in d_1 or because they are not entailed by it, then it is possible to formulate a definition, d_2, which would

Thus, the above suggestion can explain why definitions must include all predicates that reveal something about what the subject is. The claim follows from the claim that, (I), the definition of a subject is a complete account of what that subject is, and the claim, (II), that predicates in the what-it-is of a subject signify features that account for what the subject is.[69]

The above explains the claim that all and only those predicates that are predicated in the what-it-is of a subject are part of, or entailed by, the definition of that subject. What about the criterion of non counter-predication of definitory parts with the *definiendum*? Why is it that no definitory part can counter-predicate with the subject of the definition? The reason must be that if any one of the parts of the definition counterpredicates with the subject this would entail that there are more than one predicables in the what-it-is of a subject, and this is absurd. If it was possible to have more than one such predicates, it would also be possible to determine what the subject is in a number of different ways -as many different ways as there would be predicates counter-predicating with the subject in the what-it-is. Since the predicates would be different, the identity of the subject would be determined in an equal number of different ways. This would entail that one and the same subject would have a multiplicity of different natures, and that is absurd. Therefore, no more than one predicable can counter-predicate in the first figure of predication with each subject.

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include these essential characteristics (either together with those signified by d_1 or not). Then we have: (1) $d_1 = e_1 = s_1$; (2) $d_2 = e_2 = s_1$; from which we can derive (3) $d_1 = d_2$, which contradicts the initial hypothesis that d_1 is different from d_2.

[69] Definitions counter-predicate with their subjects, i.e. they belong to those subjects as unique properties in the broad sense. What differentiates them from unique properties in the narrow sense, i.e. *propria*, is that *propria* are predicated in any category of predication other than first category of predication. Definitions, by contrast, are truly predicated of their subject in the what-it-is in that they specify what kind of subject their subject is. In general, predicates in the category of the what-it-is are determining features of what these subjects are, i.e. of their nature. Hence a predicate that counter-predicates with its subject in the what-it-is, uniquely determines what the subject is. A predicable can play that role only by including as parts, or entail, all predicates signifying determining features of the subject, i.e. all predicates of that subject under the first category of predication. Therefore, a definition must include all predicates signifying determining properties of the nature of its subject.

9. Conclusion

Definition is a unique property signifying the essence of the subject of which it is truly predicated.[70] Aristotle's remarks on definitions seem to endorse a weaker and a stronger thesis, (D1) and (D2) respectively (*Top.* I.4 101b20ff.; I.5 102a1-2):

(D1) A definition is a predicable that counterpredicates in the what-it-is of its subject.
(D2) A definition is the unique property that counterpredicates in the what-it-is of its subject.

(D2) follows from the claim that a definition includes or entails all predicables predicated in the what-it-is of the subject of that definition. This claim is based on the assumption that to every subject there corresponds an essence that uniquely identifies its nature. Before examining this assumption, let us consider the steps that lead to (D2):

(1) predicates in the what-it-is of a subject, s_1, signify what s_1 is, i.e. its nature (assumption)
(2) The unique nature of s_1 is the essence (ESS) of s_1 (assumption).
(3) (from 1 & 2) The ESS includes all those features signified by predicates in the what-it-is of s_1.
(4) The formula that signifies the ESS of s_1 is the definition (DEF) of s_1 (assumption).

It follows from these premises:

(5) (from 3 & 4) DEF must include or entail all predicates in the what-it-is of s_1.
(6) (from 2 & 4) DEF is a unique property (UP) in the what-it-is of s_1.

Assumption (2) is crucial. A full exposition and defense of (2) far exceeds the scope of the *Topics*. But it is possible to stress here the following points.

There are two possible ways of justifying (2). First, by identifying the essence, i.e. the nature of a subject, with the aggregate of all its necessary properties, and thus to explain essence in terms of necessity. Then an account of the distinction between necessary and non-necessary properties would be needed -an account that would not make use of the notions of essence and nature. However, it is safe to conclude that this is not Aristotle's line,

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[70] There is no indication that Aristotle restricts 'subject' here to individual or universal subjects. Rather it includes both although it primarily points to universal subjects, i.e. ontological subjects that are themselves predicated of a plurality of individual subjects. Given the transitivity of the

at least in the *Topics*. For he accepts that there are predicables that belong of necessity to their subjects and do not signify essential properties of that subject. Thus, the essence of a subject cannot be the aggregate of its necessary properties, and consequently the definition cannot include all and only the predicates that signify necessary properties. The definition would include or entail, only those (necessary) predicates of the subject that are predicated of it in the what-it-is. Those predicates signify properties that determine what kind of thing the subject is. According to the *Topics* the predicables predicated in the what-it-is are definitions, genera and genus-like entities, such as differentiae.[71] Since definitions must include and entail all predicates signifying essential properties, they must include/entail genera or differentiae of their subjects. (*Top.* VII 153a15 ff.)

This is not yet a justification for the distinction between essential and non-essential predicates. One answer to the question how the definition of the essence of a subject is formulated is laid out in the *APo.* where the notion of explanation/cause is exploited as constitutive of the definition of a subject. This answer is further elaborated and specified in the biological works where the final cause plays a basic explanatory role and thus determines the nature of living things.

As far as the *Topics* are concerned the distinction between essential and non-essential predicates of a subject seems to be reduced to the question which predicates are predicated in the what-it-is of that subject and which predicates are predicated in other figures of predication. An account for this latter distinction is needed that will not appeal to the essential/non-essential distinction, unless the distinction is a primitive one not to be explained by any further principles. The same holds for the claim that genera and

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predication relation the definition of a subject, *s*, is also predicated of whatever subjects *s* itself is predicated of, i.e. of whatever subjects are the kind of subjects specified by the definition of *s*.

[71] By contrast accidents or *propria* cannot be included in the definition. *Propria* are excluded since they only qualify the subject in some respect and do not provide some information about its nature. (*Top.* VI.3 140a35) Accidents are excluded for they are predicables that may or may not belong to one or more of the things that fall under the genus or the species (*Top.* I.5 102b6-9) Thus the

differentiae are predicates in the what-it-is cannot be based on the claim that they denote essential properties.[72] I will address this claim, i.e. that the only essential predicates included in definitions are genera and differentiae, in the next chapter.

To conclude, the *Topics*' evidence discussed so far suggests that although the criteria for the essential/non-essential divide and the criterion of being predicated in the first figure of predication are equivalent, there is no indication of further explanation for these distinctions. The only positive claim is that predicables that are definitions, genera or genus-like entities, fall on the one side, while accidents and *propria* on the other.[73] The claim that definitions are composed out of genera and differentia*e* gives a clue for the direction implicit in the *Topics*. What necessitates that all predicates signifying essential properties are either genera and differentia*e* is that in explaining what a subject is, one has to look for what distinguishes the nature of a subject from the corresponding natures of different subjects under the same genus. At least in the *Topics*, the dialectical exchange of arguments concerning definitions, depends on a study of the differences and similarities between subjects under common genera. Predicates in the first figure of predication are found among the similarities and differences that characterise the subject in question as contrasted with other subjects of the same genus.[74] So predication in the what-it-is can be explained by means of the method outlined in the *Topics* for collecting predicates that signify what that subject is. A description and brief analysis of this method is found in the first book of the *Topics*, and I will turn to it now.

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inclusion of an accident into a definition would make the definition non-convertible with the *definiendum*. (*Top.* VI.3 140b15 ff.).

[72] This would be circular. For, (a) an essential property of a subject, *s*, is one signified by a predicate predicated in the what-it-is of *s*, while (b) a predicate is predicated in the what-it-is of a subject, *s*, iff it signifies an essential property of *s*.

[73] Aristotle's rationale seem to be that a predicate, *p*, predicated in the what-it-is of a subject, *s*, is part of the definition of *s*, because (I) a definition signifies what kind of subject *s* is, (II) predicables predicated in the what-it-is signify what a subject is.

[74] This would probably involve some divisions, not necessarily complete, of each genus.

1. Introduction: Definition as composed out of genus and *differentiae*

In the deduction of the four predicables in *Topics* I.8 Aristotle restricts definitory parts or predicates to genus and differentiae. Definitions are composed out of a genus and one or more differentiae. (103b15-6) What guarantees this restriction? What is it that establishes that the only essential predicates, apart from definitions, themselves are genera and differentiae? Definitions composed out of genus and differentiae are the outcome of the method of division. The method and the formulation of definitions obtained by divisions are discussed in the *APo.* II.13-14, *PA* I. 2-5 and *Met.* VII.12. Although the *Topics* do not include a theoretical discussion of the method as such, they contain multiple references to the actual use of some sort of divisional process.[75] The passage which comes closer to a theoretical discussion of this method of determining what a given subject is, is the one that discusses the study of differences and similarities as a way for formulating accounts of what an entity is. It is found in *Top.* I. 14-18, which deals with dialectical reasoning and its instruments. The points made in these chapters can clarify the composition of definitions by means of genus and differentiae.

In *Top.* I.12 dialectical reasoning is divided into two kinds: syllogism (or deduction) and induction. (105a10 ff.) The basic elements of dialectical syllogism include the following four tools by means of which we are equipped for making deductions: (a) obtaining the premises, (b) distinguishing in how many ways a word is said, (c) finding differences, and (d) examining of likenesses. (*Top.* I.13 105a21-25) I will focus on steps (c) and (d), for they correspond to (I) the study of the differentiae that divide things under a common genus and (II) the study of the common genus respectively. Examining these steps offers some insight on the claim that genera and differentiae are the only predicables that are definitory parts.

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[75] The only relevant reference to διαίρεσις in the first book is at 105b33-5. But there are references to the method in later books: II.1 109b13-29; 3 110b12-5; 110b28-30; III.1 120b36-121a6; 121a29; 121b19-20; IV.2 122a25-7; VI.6 143b1; 144a1-3; VI.13 151a1; VII.1 151a15; 157a7-8; VII.3 158b22; 158b32; VII.14 164b6.

2. The study of differences

The study of differences consists in comparing different subjects under either (a) a common genus, or (b) under different genera that are not remote, i.e. genera that are not very different from each other:

> ...one should study both things within the same genera, in comparison to each other (e.g. in virtue of what does justice differ from courage, or wisdom from moderation; all of these are from the same genus), and things from a different genus, in comparison to something else that does not differ too very much (e.g. in virtue of what does knowledge differ from perception) (I.16 107b38-108a5, Smith's tr.)

Aristotle refers to differences here by employing the word διαφορά. Although the word as a technical term refers to differentiae, translators have been reluctant in rendering it as differentia here. The reason is that the search for differences is not exhausted by the search for differentiae.[76] Indeed the difference between two subjects may be due to predicates that are not differentiae in the technical sense. So the study of the differences between subjects will not only reveal differentiae that divide them out of the common genus, but also different unique properties (in the narrow sense) that belong to them.[77] A difference between two subjects with respect to different unique properties will constitute a necessary difference between them. Such a necessary difference between two subjects is relevant to the study of differences,[78] since the study aims at establishing whether the compared subjects are the same[79] or different. (108a36-b3) But there are further aims of the study of differences:

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[76] Both Smith's translation and the revised Oxford translation edited by Barnes render the word as 'difference'. Smith justifies his translation thus: 'the less technical 'difference' fits better with what Aristotle says later in I.16 and I.18 (the point may be that finding the differences is important, among other reasons, because it can yield differentiae).' (1997:89)

[77] The study will also reveal some different accidents that belong to the examined subjects. However, accidents could be disregarded here because they are predicates that do not belong to their subjects of necessity, while the study of differences is directed to necessary predicates.

[78] From the fact that two different predicates necessarily belong to two different subjects it can be inferred that the two subjects are different. Equally from the fact that two subjects share all their necessary properties, or one unique property, it can be inferred that they are the same.

[79] Aristotle discusses the three senses in which two things are said to be the same in *Top.* I.7. Two things might be the same either (I) in genus, when they fall under the same genus (2) in species when they belong to the same species, i.e. when there is no specific differentiae that belongs to the one but not to the other, or (3) in number (103a8-14). Although sameness in (1) and (2) involve the examination of necessary predicates such as the genus, the differentia and the species, case (3) is more

Finding differences is useful both for [a] deductions about what is the same or different and [b] for recognising what each thing is[80]... But it is useful for recognising what something is because we usually separate the unique account of the being of anything by means of the differences appropriate to it. (I.18 108a38-108b6)

Aim [a] can be fulfilled by the study of any necessary predicate of the subjects compared. If any two subjects differ in any of the predicates that necessarily belong to them, then a deduction can be constructed proving that they are different.[81]

However, with respect to aim [b], namely recognising what each thing is, the necessary predicates of a subject will not suffice. What is aimed at, the 'unique account of the being of anything', is the definition of the subject.[82] So what is needed are the definitory or essential predicates that differentiate the subject. So the reference of διαφορά in that respect must be restricted to essential differences or differentiae. What is separated by means of those differentiae is the definition of the essence of an entity, and it is separated from the definition of other subjects under the same genus. Then, in order to formulate the definition of the essence of a subject one has to find the differences that (a) separate the

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complex. It is sub-divided into (a) when the same 'is indicated by means of a word or a definition, e.g. a coat is the same as a cloak or a two-footed terrestrial animal as a human' ('the strictest and primary way'), (b) when the same 'is indicated by means of a unique property, e.g. what is receptive of knowledge is the same as human' and (c) when the same is indicated with an accident (*Top.* I.7 103a25-32).

[80] Brunschwig reads τί ἔστι ἕκαστον–instead of τί ἕκαστον ἔστι-, and render the phrase 'l' essence des choses' (1967: *ad loc.*), thus pointing to universals such as the species. Smith renders ἕκαστον as particular, although he seems to take it as referring to the subject of definitions.

[81] See 108b1-2. In the illustration perception and knowledge are differentiated by means of the following properties. For knowledge it is possible of getting it back when one looses it. For perception this is impossible. From the two premises it can be proved that perception is different from knowledge.

[82] Definition was defined at 101b36 as the 'account of what-it-is to be.' So the 'unique account of the being' here must be a reference to definition. This requires understanding that 'being' in 108b5-6 replaces the expression 'what-it-is to be'. [Smith (1997:101)] This lends further support on the reading of *Top.* I.9 proposed above (ch. 2). It was suggested that Aristotle deals with figures of predication and not with categories of being. It was argued that the category of what-it-is to be does not designate the category of substance but the first figure of predication, namely predication in the what-it-is or essential predication. If the suggestion that 'being' here replaces the expression 'what-it-is to be' is correct then this is one example where the term οὐσία refers to essential predication in general.

subject out of the genus and, thus, (b), distinguish its essence from the essence of other co-ordinate subjects of that genus.[83]

The following difference between the two tasks of the study of differences emerges. In the case of constructing deductions for proving that something is the same or different it suffices to spot a difference in the set of the predicates that necessarily belong to the compared subjects. By contrast, in cases where the aim is the formulation of definitions what one aims at are essential predicates that differentiate the co-generic subjects, i.e. one aims at discovering their differentiae. Why is such importance placed on the latter set of differences? To find out why we need to look at the actual work the two kinds of differences play in the respective tasks that are assigned to their study.

First let us examine a distinction that is relevant here. As Smith points out in both cases the question is not whether two things are different but in virtue of what they differ.[84] This can be understood in two ways. First as meaning that knowing that two subjects differ with respect to any difference whatsoever is *ipso fact* knowledge why they differ. Secondly as meaning that granted that there is a difference between two subjects one has to search for some further predicates the possession of which explains this difference. In the latter case, the study of differences aims at the discovery of some basic differences from which a number of other differences between the two subjects follows. The latter properties will be ontologically and explanatorily dependent on the former ones. Although such a distinction can be traced in other works the *Topics* are silent with respect to these two ways of understanding why two subjects differ. But if there is no such a structure of priorities between predicates, what distinguishes differences useful for defining from differences

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[83] It must be noted that the above passage supports the claim that differentiae are predicated in the what-it-is. A differentia is explicitly said to clarify what the thing in question is, it is not completely inappropriate as an answer to 'what is it?' questions.

[84] See also *Top.* VI.6 143b3-10. As Smith puts it 'finding differences is not discovering *that* things differ but discovering *in virtue of what* they differ. Within a single genus, the difference in virtue of which one species differs from another is the differentia in a technical sense' (1997:100).

which are mere necessary predicates that are helpful only for differentiating between subjects but not for defining? Let us look at the tasks for which differences are collected.

The first task is the formulation of deductions that prove that the subjects under examination are different. They will be of the following form (*Top.* I.13 105a28-30):

> Knowledge is possible to get back when one looses it.
> Perception is impossible to get back when one looses it.
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> Therefore knowledge and perception are different.

So the first task of the study of differences can be formulated thus:

(1) In order to prove for any two subjects, *s1* and *s2*, that they are different there must be a predicate, *p*, such that *p* necessarily belongs to *s1* and necessarily does not belong to *s2*.

Neither of the two predicates in this example is a differentia of either knowledge or perception.[85] Nor are they unique properties. Both are necessary properties that differentiate between two subjects that are one by analogy.[86] There is no indication here whether each of these differences is entailed by some more basic one, i.e. whether there is some fundamental difference explaining why the subjects display this pair of differences. Hence, priority relations between predicates, grounded e.g. on entailment, seem to play no role here.

But what about cases where the subjects fall under the same genus? (108a1-4) Here the aim of the study of differences is the formulation of definitions stating the essence of the compared subjects. The study of differences is useful here 'because we usually separate the

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[85] Knowledge and perception are one by analogy. As perception is to the perceptible is knowledge to the knowable. They fall under the same highest genus, they are relatives. They also fall under the same sub-division of that genus relative: both are states (*Cat.* 7 6a36 ff.). Cf. Alexander's list of predicates that differentiate perception from knowledge (*In Top.* 116 10-31).

[86] Things that differ further than things one by analogy, are not worthy of study for the differences between them are completely obvious. (*Top.* I.16 108a5-6) Smith objects that it is not obvious in virtue of what things whose genera are further removed differ, but only that they differ. (1997:100) So he takes Aristotle as making this latter point. By contrast, Alexander says that the differences are obvious because nobody asks in what, for instance, does man differ from wood (*In Top.* 115 20-21). His point is that it is impossible to mistake man and wood as identical, as in the case of perception and knowledge. The reason why one may be mistaken in the latter set of cases is that in them there is a common element between the two subjects. So Aristotle's point may be that, unlike the case of things which are the same in genus or the same by analogy, there are cases where there is no identical element, where the subject are very distant. In their case there is no common element that can serve as a ground for a false identity statement nor there is common ground from which an investigation of their differentiating properties can start.

unique account of the being of anything by means of the differentiae appropriate to it.' (108b4-6) The procedure according to which a definition is composed here presupposes that the *definiendum* is contrasted to other subjects under the same genus, and not considered in isolation. The definitions of the subjects are composed out of contrary differences that sub-divide the common element, the genus, in some relevant way. The differences are necessary predicates that distinguish between various co-ordinate species of the same genus, and in giving the account *explain* what the subject is. The text does not explicitly suggest that these differences are explanatorily more basic and explain further less basic differences between the subjects. Nevertheless, as we will see in section 4, the definitory elements are ordered according to an order of natural priorities, which correspond to an order of priorities with respect to knowledge. If the order of definitory predicates displays relations of priority with respect to knowledge, then their order must be related to explanatory concerns. The definer, by aiming at predicates that are more knowable, aims at predicates that have greater explanatory power than those that are less knowable. So the difference between studies of subjects under different and under the same genus, must be that in the latter case the subjects are divided and defined in virtue of predicates that can give an explanation of what the subject is. So this might be the feature then that divides between the two kinds of differences. Although a detailed account of the explanatory power of essential predicates emerges in the *Analytics*, there is reason to believe that the *Topics*' account is compatible with such a development.

But there are two further difficulties here. First, why this cannot be effected by the collection of other necessary predicates, such as *propria*? Why are they barred from being part of the unique account of the being of the subject? One possible reply is that such predicates already uniquely identify their subject without signifying what-it-is. Thus they can be used for showing that two subjects are different, but they cannot show what these subjects are. This may not be a very satisfactory answer, but points to the primitiveness of the criterion of being predicated in the what-it-is. There seem to be no other criterion for

judging whether a predicate is a definitory one. Secondly, what about other necessary predicates which are neither unique, nor counter-predicate with their subject? What bars them from being included in definitions? These predicates are consistently omitted in the whole discussion of the predicables, although it seems obvious that there are such predicates. The following is only some speculation concerning their exclusion here.

The above difficulties appeared in the previous chapter with respect to the difference between essential and non-essential but necessary predicates. Predication in the what-it-is seems to be a criterion for which no further justification is offered. The study of differences and similarities may be the background on which such a distinction is proposed. It may also offer some reason why Aristotle seems confident about the distinction between differentiae, which are predicated in the what-it-is, from other necessary predicates which like differentiae also do not counterpredicate with their subject but unlike differentiae are not predicated of it in the what-it-is. The method of searching for similarities and differences may involve some constraints that suffice in restricting the scope of definitory parts to differentiae only. One such constraint must be the introduction of the common genus of the compared entities. The introduction of the common genus is dealt with in the second leg of the method, namely the study of similarities.

3. The study of similarities and its usefulness for forming definitions

The study of similarities is introduced by distinguishing two classes of subjects to which the study applies, namely things under different genera and things under the same genus. Similarities are studied at two levels depending on whether the things compared fall under opposite genera, as e.g. perception and knowledge (*Top.* I.17 108a7-10), or under the same genus as e.g. the species man, horse and dog of the genus animal. (*Top.* I.17 108a15-6) This division corresponds to the division of the two tasks of the study of differences considered above. Similarly the study of similarities has different tasks depending on the kind of subjects it examines:

(a) As for similarity, this should be examined first, in the case of things in different genera: as the one is to the one, so the other is to the other (e.g. as knowledge is to the known, so is perception to the perceptible); and as one thing is in one, so is another in another (e.g. as sight is in the eye, so intelligence in the soul, or as a calm is in the sea, so is a stillness in air)...
(b) Next, things in the same genus should be examined to see if anything the same belongs to all of them, e.g. to a human, a horse, and a dog (for to the extent that something the same belongs to them, to that extent are they similar). (*Top.* I.18 108a7-17; Smith's tr.)

The first difference is that in (a) the description of similarity relies on an analogy between four terms: as *a* is to *b*, so *c* is to *d*. The similarity need not be grounded on a species-genus relation. The terms in the two analogues may be related as a capacity is to its object (perception/perceptible), as a function is to the organ that performs it (sight/eye) or as a subject to its property (sea/calmness). Thus the method has a wide application and there is a variety of relations the schema may apply to.

This part of the study is only a preliminary for the second and more crucial one, namely the study of similarities between a number of subjects in order to arrive at the common genus. The study of subjects under different genera is practiced as a preparatory exercise for the more crucial one. The task of detecting similarities between things under different genera is a more demanding task than asking for the genus of a number of subjects under the same genus. (*Top.* I.17 108a12-4)[87] Thus a mediate use of task (a) is that it constitutes a good training for performing task (b). If one is trained in cases where the subjects fall under different genera, he will be better equipped to deal with the simpler cases of subjects under a common genus.

Aristotle does not specify whether in the case of co-generic subjects, the quest for similarity aims at finding the higher common genus, or whether it aims at the common genus as well as to other lower common genera between the subjects that are being compared. His

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[87] The verb συνοραν that Aristotle uses here, seems to be pointing to the fact that it is easier in their case to have both in front of our mind's eye and recognise their common generic character. Probably the expression points to the fact that in their case we consider only three items, the contrasted items and the common genus. While in the case of similarity by analogy we consider four items belonging into two contrary pairs.

example allows for the latter interpretation. The subjects man, horse, and dog have in common more than just the higher kind living thing (e.g. they are vivipara, terrestrial and footed). Thus the similarities may be common predicates in general, and if so the study of similarities reveals more essential predicates than just the higher genus.[88]

Further the study is useful for formulating definitions,[89] 'because if we discern what is the same in any case, we shall not be at a loss as to what genus we must put the things proposed into when we are defining.' (*Top.* I.18 108b20-2) The things to which Aristotle refers here are subjects under a common genus.[90] Aristotle's justification for the usefulness of the study suggests that determining the common genus is a study that precedes the examination of differentiae that belong to the subjects. Hence, it precedes the formulation of

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[88] Alexander's illustrations include the predicates 'having a soul' or 'capable of perceiving', as common generic predicates of species of animals (Alex., *In Top.* 124 1-2).

[89] See also Appendix I for a discussion of the definition of chance and luck in the Physics as an application of the method of the study of differences and similarities. The study of what is similar is also useful for inductive arguments and for deductions from an assumption. (*Top.* I.18 108b7-9) With respect to inductive arguments the study is useful 'because it is by bringing in particular premises about similar cases that we claim a right to bring in the universal premise.' (108b9-11) Brunschwig notes that induction has two kinds of objects, namely the particular cases exhibited by the dialectician and the universal proposition that he induces from the particular cases: 'the technical sense of induction is the result of a kind of confluence between the two aspects of this operation, designated by the same verb επάγειν' (1967:137). There is an ambiguity that concerns the first of those two kinds of objects. Are the subjects of particular premises individuals or species? If it is the latter then the study of similarities should aim at finding the common genus of those individuals. However, the similarity that the study aims at discovering is the common genus of a number of differing species. This is made explicit at 108b24-32 [Brunschwig (1967:137)]. Secondly, Aristotle uses an example of this kind, namely the species man, horse and dog to illustrate the study of similarities at 108a14-17. Therefore, it is more likely that the subjects of individual premises are species rather than individuals. According to Smith if 'the similar cases were (perceptible) individuals then the relevant criterion of similarity would be a perceived likenesses, something not likely to be advanced by the kind of study Aristotle has in mind' (1997:102). Therefore, Smith takes induction here to be the generalisation from many similar species to a common genus.

With respect to deductions from an assumption the method is useful 'because it is accepted that however matters stand with the one group of similar things, so they also stand with the rest.' (108b12-4) Aristotle refers here to arguments from analogy which have the following structure: (1) given two similar subjects, *a* and *b*, whatever is true of *a* is true of *b*, then (2) an argument is made about one of these subjects, say *a*, and (3) it is concluded that an analogous case can be made with respect to *b*.

[90] The objects of the study here are probably species and not individuals. Brunschwig notes that *hekaston* in line b20, must mean the species rather than the individual. For our passage is parallel to *Top.* I.17 108a14-7, where what is at stake is how to find the common genus between different species. Further, if the study described here concerned individuals the result could be a common definition, not a common genus (Brunschwig [1967:137]). Although this second reason is controversial, the first suffices to establish that Aristotle refers to species here, or at least to subjects differing in species.

their definitions. At this stage of the study it may not yet be established that the subjects fall under the same genus. One probably has to rely on general opinions holding that the subjects do so. These may be confirmed or rejected in the process of considering their differences and formulating their definitions.

The study begins with the collection of common predicates between the subjects, only one of which is the genuine genus (assuming that they fall under one genus). But how is one supposed to pick out the genus out of a variety of common predicates? Aristotle says that the genus is 'that one of the things in common which is predicated most of all in the what-it-is is the genus.' (*Top.* I.18 108b22-3) The thing predicated most of all in the what-it-is might refer either (a) to the lowest or narrowest common genus, or (b) to the highest common genus.[91] The examples point to (b), though not unambiguously.

Two examples are given at 108b23-31. The study of similarities between things under opposite genera can be useful for constructing definitions in the following way:

> ...a calm in the sea and a stillness in the air are the same (for each is quietness) or a point in a line and a unit in a number (for each is a beginning). Consequently if we give *what is common* to them all as the genus, we shall not seem to be defining strangely.' (*Top.* I.18 108b24-8; Smith's tr.)

In the first example calmness with respect to sea and stillness with respect to air are sub-divisions of quietness, i.e. items that are categorically lower and inside this common predicate. Quietness must be the genus which is predicated most in the what-it-is of those subjects. But it is not clear whether this is the highest one. However, in the second example, the predicate 'principle' seems to be such a highest common genus between point and unit. This implies that what is mostly predicated in the what-it-is is the highest common genus between the subjects.[92]

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[91] E.g. in the case of the species man and horse to the lower sub-genus viviparous terrestrial animal, or to the highest kind, living thing. (Smith [1997:102])

[92] This is also suggested by the example offered in the course of laying out the study of differences, at 108a15-7. Aristotle refers to things that compose a definition, thus one expects that the item appearing in the genus position will be what is mostly predicated in the what-it-is. The example

If so then the study of similarities aims primarily at positing the highest common genus, and not some other predicate which signifies a narrower sub-class inside that genus. How is this priority of the generic element to be understood? One way is to understand the claim quantitatively: the highest common predicate is the only predicate that is predicated of all the subjects that fall within the limits of the study. The study of the subjects will reveal a number of common predicates, the only predicate that will extend further than any other will be the highest common one. So 'mostly predicated' may mean 'most extensive'. Nevertheless, the study of similarities will lead to the discovery of lower common predicates as well. These predicates will signify sub-genera of the higher common genus or differentiae.

4. The essential/non-essential divide and the distinction between what is more known in itself and more known to us

The study of similarities is suggested as the first step in unraveling the essential predicates of a subject, i.e. the predicates predicated of it in the what-it-is. The selection of the subjects relies on *endoxa*. This seems to leave open the possibility that the subjects may not after all fall under the same genus. And if the subjects fall under different genera, they will not share any essential predicates. In order to examine this problem let us turn to the study of similarities between things under different genera. (108b23-31) This will also help with the question how is it guaranteed that the study of differences will get only essential predicates of the subjects and not some merely necessary predicates as well.

There is an analogy between the study of similarities of subjects under different genera and the study of subjects under one genus. Both studies aim at a common generic predicate which is placed as their genus in a (tentative) definition of their essence.[93] The common

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involves the species man, horse and dog of the genus animal. The species have in common more than just the higher-genus. However, their definition begins from the highest common predicate, namely animal. Thus what is most predicated in the what-it-is is the highest genus.

[93] The definitions will be of the following kind: unit is the *beginning* of number or point is the *beginning* of line, or calmness is quietness in the sea and stillness is a quietness in the air. (108b23-31)

predicate belongs to the subjects in a *manner similar* to that in which, say, the genus animal belongs to the species, man, horse, dog etc. The similarity is that a generic, or quasi-generic predicate in the case of subjects under different genera, is exemplified in different ways in each subject. This suggests at least five terms: there are at least two subjects, and two corresponding predicates belonging to them, that exemplify in different ways the common generic nature. This means that the differences one looks for must be such that are related to the common genus by specifying some aspect of it. Not just any difference between the subjects would do.

The definitions of unit and point proposed as illustrations are only partially justifiable definitions and not real definitions. According to Brunschwig, these definitions are *justifiable* because what is less known (to us) is defined by means of that which is more known (to us). (1967:138) However, they are only *partialy* justifiable because they define what is more knowable (in itself) by means of what is less known (in itself). (see 141b19 ff.) According to this suggestion the study of similarities, both in the case of things that fall under the same genus and in the case of things under different genera, aims at establishing a generic predicate that places the subjects under the same branch of classification. Yet there is a difference with respect to what the outcome is in each case, since in the case of things under different genera the study does not yield the genuine genus of the compared subjects but a *quasi*-generic predicate. The reason is that similarity in the latter case is not established on what is more knowable by nature, i.e. on an essential feature of the subjects. The similarity is established on some connection that is more basic with respect to the way we are familiar with the subjects, and not on a similarity which is basic with respect to their nature. Such a genuine essential common generic element exists only in cases of subjects falling under one genus. So in order to find real genera and formulate real definitions one has to compare subjects under the same genus. It is only when considering such a class of subjects that the study can deliver starting points for genuine definitions of the subjects studied.

Let us summarise the points of the study of similarities and differences that are relevant to the distinction between essential and non-essential predicates of a subject. The uses of the study of similarities and the uses of the study of differences are structured similarly. The two studies are complementary, at least with respect to the aim of constructing definitions and forming deductions. The study of differences is divided into two stages depending on the kinds of things that are being compared by means of it. Studying the differences between things under different genera is useful in its own right for forming deductions that will prove that two subjects are different, but it is also a good exercise for studying the differences of things under the same genus. The latter study is a much easier task, so that if one is well-trained in finding the differences between things under different genera, he will thereby be better equipped to deal with the differences between subjects under the same genus. On the other hand, the study of similarities is a necessary component of the enterprise of formulating definitions because in the case of items within the same genus it helps locating the predicate that signifies the common genus. This predicate is what is mostly predicated in the what-it-is of each of those subjects and the first element in the account that states their essence. This is a first necessary criterion that the essential predicate that signifies a genus must satisfy. It is the item that is most appropriate to predicate in the what-it-is of the subjects entities. If 'most predicated in the what-it-is' refers to the most general predicate that belongs to the subjects, this essential predicate must be the highest common predicate that belongs to the subjects studied.[94]

How is this common predicate or genus related to the differences dividing the subjects? The genus is the predicate that locates the defined entity within a class of resembling subjects, and certifies that those subjects must be treated as sharing, at least partly, a nature. Subjects under the same generic nature exemplify one or more characteristics of that genus

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[94] Here some specification is needed, for it is not clear in what level of generality this highest genus is located. The genus cannot be a predicate such as the predicates 'entity', 'one' etc. which fall outside the limits of any one category. But this does not specify sufficiently the level of generality.

in different ways or respects. So the genus can be viewed as the aggregate of these characteristics. Then the study of the differences between the subjects, as directed to the formulation of definitions, will consist in studying the contrasting ways the common generic characteristics are realised in each subject. Thus this comparative study, conducted within the limits set by the common generic nature, must proceed by means of differences that belong to, or fall within the limits of, the genus. This notion of belonging needs clarification.

The notion of belonging must be determined in a way that will allow for the following element: the differentiae are specifying how the subjects differ in the way they possess the common generic nature. The genus can be regarded as a determinable complex property, an aggregate of further determinable features, that can be determined in a number of respects. This is the common generic nature. The determinations it receives are the differentiae belonging to it and differentiating the subjects falling under it.[95] One possible line then is that differentiae belong to the genus because they entail the genus in the following sense: if a differentia, *d*, belongs (is predicated of) a subject, *s*, then there is a genus, *g*, such that *g* necessarily belongs to (is predicated of) *s*, and this is the genus of *s*. The common genus is something more known in itself when contrasted to the subjects that fall under it. The differences of those subjects are considered within the limits of that genus.[96] Placing the

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[95] The idea that the relation between genus and differentia is similar to that between determinate and determinable properties is proposed by Granger. (1992:71-81) Furth makes a similar suggestion: 'differentiation of co-ordinate kinds... connotes a manner in which relatively undetermined, only generically characterized structures are variously specialized and specified –in this sense the focus is accordingly upon what a given differentia is a difference *of*: here, of an underlying generic potentiality, and the differentiae are the particular manners in which that potentiality is found to be restricted or reduced.' (1988:102) This suggestion can be illustrated thus: the nature of the genus animal requires that the species that fall under it will have certain properties with regard to locomotion, nutrition, reproduction and so on. The genus is determined in these respects by different properties, and these properties differentiate between different kinds of animals which exemplify the determinable generic nature in the corresponding ways.

[96] If, for instance, the common genus is the genus animal then there are specific lines of differentiation with respect to the different characteristics that constitute the common nature that the genus signifies. For if a subject is a species under the genus animal it must possess some characteristic with respect to locomotion, breathing, nutrition (Charles [1999:246]). So once a number of subjects are settled down as species of the genus animal their differences must be searched for with respect to

species inside the genus amounts in setting restrictions concerning the natures of the subjects studied. This must be what guarantees that the differences discovered are essential characteristics and thus that they can be used in forming definitions revealing the nature of the subjects.

On the other hand, definitions formulated in the case of things under different genera by placing the higher common generic predicate as the genus are not real definitions. For neither this *quasi*-genus is the real genus of the subjects in question, nor the differences arrived at are the differentiae of those subjects. Those differences are not predicated in the what-it-is of the subject in question.[97] The generic predicate and the differences are not the real genus and differentiae because they are things more known to us rather than things more known in themselves (when compared to the subjects considered).[98] The predicates signifying contrary properties may help to discriminate between two, or more, subjects, they do not reveal, however, the nature of the subject to which they belong. Further, the similarities between subjects under different genera are not their proper genera. Again the reason is that the genus is what is mostly predicated in the what-it-is of the subjects under it, and this is not the case for the *quasi*-genera of similar things under different genera. This

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these structural characteristics of the genus. A difference between those subjects with respect to some other characteristics, e.g. a quality such as color, are irrelevant to the genus in the sense that they do not entail the genus, and thus do not constitute differentiae of those subjects.

[97] They might signify necessary properties of those subjects but not essential ones. There is a further defect of the study of differences of things under different genera suggesting the impossibility of arriving at genuine definitions by means of such a study. This defect can be illustrated thus: perception, we are told, differs from knowledge in that although it is possible for knowledge to get it back when one looses this is impossible for perception. The difference here consists in a pair of contraries, where the one is the negation or the privation of the other. This is not the appropriate way to divide a genus if the aim is to describe the nature of the species that fall under it. (*PA* I.3 642b22 ff.) So this way of dividing different subjects cannot yield predicates that signify essential properties of the subjects. For the order of essential predicates cannot be captured by means of dichotomous divisions. How can this order be captured relates to the question how are the essential properties of a subject ordered which is examined in the next section.

[98] The nature of these *quasi*-genera is relevant to the discussion of essential predicates. For these *quasi*-genera are not essential predicates, and thus they illustrate what essential predicates are not supposed to be. The grouping of subjects under those *quasi*-generic predicates seems to consist in a collection of subjects with respect to some coincidental similarities with respect to some secondary characteristic. For instance, sea resembles the air because both may have a sort of quietness. But the exemplification of quietness by either of the two does not determine their nature, i.e. quietness is not predicated in the what-it-is of those subjects, for quietness is not what air or sea is.

fact is confirmed by means of an epistemological consideration. Namely, that the definition in which the genuine genus is placed first, should normally define what is less known (in itself) by means of that which is more known (in itself), whereas in the case of the study of similarities of things under different genera the definition formed by means of the common generic predicate defines what is less known (to us), i.e. what is more known (in itself), by means of what is more known (to us), i.e. what is less known (in itself). Therefore, in the case of things under different genera the two studies, i.e. that of similarities and that of differences, seem independent from one another.[99] The study of subjects under different genera cannot explain something about the real nature of those subjects. It can only illuminate in what respect those subjects differ or are similar when contrasted to some independent or remotely related subjects. Hence the study can be used to correct certain misconceptions concerning those subjects, and to train one in order to be capable of searching for genuine definitions.

If the distinction between what is more and less known in itself is what distinguishes genuine genera and definitions of a subject from *quasi*-genera and *quasi*-definitions one expects that the same distinction would hold for the distinction between genuine differentiae between subjects and mere necessary differences between them. This suggests that the ontological distinction between an essential predicate, and a *proprium* can be grounded or verified by means of the method of division or the study of similarities and differences. This method is what guarantees that the definitions formulated by means of it reveal the real nature of the subjects studied.

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[99] Aristotle gives examples of differences between subjects under different genera and he also gives examples of common *quasi*-generic properties of such subjects, but he does not offer examples of definitions formed by putting together the results of these two studies. Presumably because such definitions will not be genuine definitions since they would not signify the essence of the subject.

5. Priority in Nature between the parts of the definition in the *Topics* and the *Categories*

The relation of natural priority between predicates that are predicated truly of a subject determines, at least to some extent, what is predicated of that subject in the first figure of predication, and therefore what is part of the definition or essence of that subject. In the previous section it was suggested that the study of differences and similarities of subjects within the same genus, which aims at collecting predications in the first figure and formulating definitions of those subjects, must keep track of what is more knowable in itself or in nature. This is in contrast, at least at the initial stages of the study, with what is more familiar to us. What is of interest is whether this order of priorities with respect to knowledge is merely an epistemological order, or whether it corresponds to a real order in the features characterising a subject. In order to argue that there is such a correspondence, I will examine the notion of natural priority between the features of a subject in the *Topics* and the *Categories*.

I will start from some consideration found in *Topics* VI.2 concerning the relation between the genus, which is the definitory element that is mostly predicated in the what-it-is and presumably the ontologically prior one, and the differentiae or the species defined by means of it. Aristotle offers a number of criteria for testing whether a proposed definition is correct. The criteria consist in a number of relations that must hold between genus, differentiae and *definiendum.*[100] The most relevant relation to the question concerning the determination of predicates that signify essential properties is the relation of natural priority. In order to respect this order, when giving a definition, one must look:

[A] whether the species is naturally prior than the genus and abolishes the genus along with itself; *for the contrary seems to be the case.* Moreover,

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[100] The relation between the elements in a definition is characterised in a number of binary relations: the species partakes of the genus, while the genus belongs to the species, the genus is predicated of the species, and the species is placed within its genus. The proposed definition is correct if genus, differentiae and definiendum satisfy the above criteria. If not the proposed genera or differentiae fail to signify essential characteristics of the subject; hence the proposed definition fails to signify the essence of the subject.

[B] if it is possible for the genus stated, or for its differentia, to be absent, e.g. for movement to be absent from the soul, or truth and falsehood from opinion, then neither of the terms stated can be its genus or its differentia; for it seems that the genus and the differentia accompany the species, as long as it exists. (*Top.* VI.2 123a14-9).

According to [A], the entities signified by the definitory predicates must be naturally prior to the *definiendum* in the sense that the latter presupposes the former. This may mean that given that a species, *S*, under a genus, *G*, exists, *G* necessarily exists (whereas the opposite does not hold).[101] If natural priority is understood in those terms it seems to be equivalent to:

(1) for any two entities *x* and *y*, related in a definition as genus to species, *x* is naturally prior to *y* if when *x* ceases to exist *y* ceases to exist as well.

This condition is sufficient only for testing whether in a proposed definition the genus is indeed naturally prior or not, and thus whether the definition should be rejected or not.[102] It also determines, partly, natural priority. The genus is naturally prior to its species in the sense that whenever the genus is abolished, the species must be abolished. The same holds for differentiae. A further device for detecting the relevant priority relation is proposed, section [B] above, by following the opposite direction.[103] Since genus and differentiae must be naturally prior to the species, the latter cannot exist without the former being present in it. If this was possible then abolishment of the genus would not entail abolishment of the species, against (1) above. This may suggest that the genus exists independently of its species in the following sense:

(2) for any two entities *x* and *y*, related in a definition as species to genus, *x* is posterior to *y* if *y* exists independently of whether *x* exists.[104]

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[101] Or it can be understood as meaning that the species denotes a narrow class within the larger class of entities that fall under the genus, so if the species is predicated of a subject so is the genus (whereas the opposite does not hold).

[102] As Alexander comments the *topos* from natural priority in *Top.* 123a14 ff. is not constructive, but it only serves destructive purposes. One can only reject a definition because it does not satisfy the natural priority condition but the fact that it does satisfy the natural priority condition does not guarantee that it is the correct one. (Alex., *In Top.*, 320 29-321 5)

[103] Since 'being naturally prior than' is a two-place relation the priority can be detected with respect to either of the two terms of the relation.

[104] So natural priority will be defined thus: for any two entities *x* and *y*, related in a definition as species to genus, *y* is naturally prior to *x* if *y* exists independently of whether *x* does.

However, to ascribe (2) to Aristotle is misleading. All he says is that if either the genus or the differentia can be absent from the species then the proposed definition must be rejected because the genus and the differentia of a species accompany the species for as long as it exists. So there is no commitment concerning the existence of the genus when the species is abolished. By contrast, (2) assumes that the genus exists independently of whether its species do. According to (2) if a species x ceases to exist, and hence x is not present in its genus y, no necessary implications follow concerning the existence of y. But if it is possible for y to survive the loss of any of its species, it is possible for y to survive the loss of all its species. Hence, y would exist even if none of its species were, which seems absurd. Further, (2) is not equivalent to (1), because (2) entails (1) but it is not entailed by it. In order to get a proposition equivalent to (1), then (2) must be weakened thus:

(2*) for any two entities x and y, related in a definition as species to genus, x is naturally posterior to y if y cannot be absent from x as long as x exists.[105]

(2*) does not entail that the existence of a genus is independent from that of its species. And, (2*) entails and is entailed by (1), so they are equivalent.[106] Thus the claim that species are ontologically dependent on their genus and differentiae, because they are naturally posterior, must be understood in terms of (2*) which is not committed to the independent existence of genera or differentiae. This order of priority charcterises the relation between genus and species and between differentiae and species. Since genus, differnetiae, species are ranked in the same ladder of priorities one expects that this order will characterise in general the relations between definitory parts. Let us investigate further this order of natural priority.

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[105] So natural priority will be defined thus: for any two entities x and y, related in a definition as species to genus, y is naturally prior to x if y cannot be absent from x as long as x exists. It can be further simplified thus: for any two entities x and y, related in a definition as species to genus, y is naturally prior to x if y can be absent from x only if x ceases to exist.

[106] According to (1) a genus, y, is prior to a species that falls under it, x, because x ceases to exist when y does, from which it follows that y cannot be absent from x without x ceasing to exist, i.e. (2*). Conversely, according to (2*) y cannot be absent from x unless x ceases to exist, from which it follows that if y ceases to exist x ceases to exist of necessity, i.e. (1).

6. Priority relations between genus and species in the *Categories*

The priority relations in nature between definitory parts and *definiendum* can be further illuminated by the discussion of the senses of priority in the *Categories*.

In *Cat.* 12 Aristotle discusses five ways in which two things can be related as prior to posterior. There are four to begin with: priority (a) in time, (b) in the order of being, (c) with regard to order in general and (d) in honor or nature. Then at the end of the chapter a further one is added: 'Besides those mentioned, however it would seem that there is another way (of speaking) of priority. For among the things that reciprocate as to implication of being, (e) that which is in any way the cause of another's being may reasonably be called prior by nature.' (14b12 ff., Cleary's tr.) There are then two references to priority in nature, in (d) and (e), referring to quite different cases.

Priority in nature, at 14b6-11, refers to what is better and more honorable. The sense is illustrated by the example of ordinary people who refer of those whom they honor more or they love as 'being prior'. This case of priority is described as the case that is 'furthest removed' from the other senses (14b10-11) or the most 'obscure' one.[107] The second allusion to natural priority concerns things that reciprocate as to implication of existence:

> for being a man reciprocates as to implication of being with the true statement about him; e.g. if there is a man then there is a true statement by which we say that there is a man. Reciprocally, if the statement is true by which we say that there is a man then there is a man. But, whereas the true statement is in no way the cause of the thing's being, still the thing appears to be somehow the cause of the statement's being true. For it is on account of the thing being or not being that the statement is either true or false.

Does this sense capture the priority relation between definitory parts and defininendum found in the *Topics*? There are at least two objections to this suggestion. First, the above

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[107] Perhaps, as Cleary suggests, this case of priority is not really significant, at least within the context of the early works. (1988:31) With respect to the other senses: (a) Temporal priority is the proper and primary sense of priority. (b) Priority in the order of being is the kind of priority that holds between two things which do not reciprocate as to implication of existence: 'for example, one is prior to two because if there are two it follows at once that there is one whereas if there is one there are not necessarily two, so that the implication of the other's existence does not hold reciprocally from one; and that from which the implication of existence does not hold reciprocally is thought to be prior.'

sense covers cases where there is reciprocity as to implication of existence. By contrast, in the *Topics* definitory parts and *definiendum*, or genus and species do not reciprocate as to implication of existence. The species is posterior in that it entails the genus, and abolishment of the genus entails abolishment of the species, but the converse is not true. Secondly, the *Categories* passage adds a further condition, absent from the *Topics*, namely that the prior item is the cause of the posterior one. If the genus/species relation falls under that sense the condition needs to be clarified: in what sense is the prior item the cause of the posterior, and how does the genus/species relation satisfy this condition?

To take the last issue first, given the *Topics* evidence it seems that the genus-species relation does not satisfy this requirement.[108] On the other hand, the first objection might be answered in the following way. The fact that the abolishment of the genus entails abolishment of the species does not entail the independent existence of the genus. For the genus to exist some or other of its species must also exist. So the priority of the genus allows for some sort of reciprocity, when we add the following qualification: the priority of the genus does not imply that any species alone reciprocates with its genus, i.e. that it entails and is entailed by it, but that some species or other does, i.e. that the genus has species.

This suggestion, however, is implicitly rejected by what Aristotle says in *Cat.* 13 about simultaneity, i.e. reciprocation as to implication of being. He argues that co-ordinate species of a genus are simultaneous in nature. If co-ordinate species of a genus are simultaneous in nature in the sense that they reciprocate as to implication of existence,[109] then the genus must be naturally prior to these species in the sense that it does not reciprocate. So at 15a5-7 we

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(14a29-35 Ackrill's tr.) Finally (c) priority with regard to any order is illustrated by this example: 'in what we call grammar the letters are prior to the syllables' (14b1-2).

[108] Nevertheless there is a sense in which the genus can be understood as the *aition* of its species to the extent that it partly explains or sets explanatory constrains for its species. Also the fact that the genus might be thought of as prior in nature and more knowable by nature to its species point to this direction. In ch. 5 I will argue that such a view is present in *APo.* II.

[109] 'Also the coordinate divisions of a genus are called simultaneous by nature. I mean those things that result from the same division are said to be coordinated with each other; for example, the winged (is coordinated) with the footed and the aquatic. For these beings are contradistinguished from each other out of the genus, since 'animal' is divided into these.' (14b32-7 Cleary's translation).

are told: 'genera are always prior to the species; since they do not reciprocate as to implication of existence; e.g. if there is a fish then there is an animal, but if there is an animal there is not necessarily a fish.' If so then the priority of genera cannot be classified under sense (e) considered above. For this latter priority holds between things that reciprocate as to implication of existence (where the one entity is also the cause of the other). But now, how are we to reconcile the claim that genus is naturally prior to species, with the claim that the genus/species relation does not satisfy the conditions set for natural priority in *Cat* 12?

The only alternative is that the genus/species relation falls under the second sense of priority, priority in being, according to which what does not reciprocate as to implication of existence is also called prior. (14a30-35) One reason justifying this is that the priority of genera over species, in the *Topics*, is grounded on the fact that genera and species do not reciprocate as to implication of existence. The *Categories* illustrate this priority by the example of the priority relations that hold between numbers: 'one' is prior to 'two' because while the existence of 'two' implies the existence of 'one', the opposite does not hold.[110] Although this is not a genus-species relation, it does not necessarily tell against subsuming the genus-species relation under this sense of priority. The sense can be wider.

So the most appropriate sense of priority applicable to genus/species relation is priority in the order of being. But then the question is could genus and species be related as naturally prior to naturally posterior, although their relation does not answer to the sense of natural priority introduced in (e) above. It may be that, although their relation does not fit the criteria for natural priority set in (e), (e) defines a narrower set of cases of natural priority. Thus priority in the order of being, i.e. the priority that applies to the relation between genus and species can be a case of natural priority. This is confirmed by Aristotle's discussion of the corresponding cases of simultaneity. Two things are simultaneous if the existence of

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[110] 'One is prior among numbers to two. For provided, that is, that 'two' exists, then it follows that 'one' must exist. The existence of 'one', on the contrary, does not imply that of 'two'. And the

either of the two necessitates the existence of the other. So simultaneity in nature is explained by means of simultaneity in the order of being. Then, by analogy, priority in nature could be explained by means of the priority with respect to the order of being. If this is right then priority in nature is not something independent from priority with respect to the order of being. There are cases of natural priority that are cases of priority with respect to being. Priority in being is a sufficient but not a necessary condition for being prior in nature. So, if something is prior in the order of being it is thereby prior in nature.

This relation between natural order and order of being is also suggested by the fact that there is no sense of simultaneity in nature corresponding to natural priority as set out in (e) above.[111] There is only one sense of natural simultaneity covering things that reciprocate as to implication of existence, while they are not related as cause to effect. This relation is opposed both to priority relations where the one term does not reciprocate as to implication of existence to the other, and priority relations where the two terms reciprocate but the one is the cause of the other. So natural priority as introduced in (e), defines only a sub-class of cases of natural priority. Namely cases where there is natural priority because although the two terms reciprocate as to implication of existence, the one is the cause of the other, and thus they are not simultaneous.

To sum up the above discussion, the classification of relations of natural priority could be represented according to the following table. Priority relations between definitory parts will come under 2.b in that table.[112]

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order of being, in consequence, cannot be changed and reversed. Thus of two things we call that one 'prior' which precedes in irreversible sequence.' (14a31-35)

[111] And it is also supported by the fact that this last sense of priority is added as a coda to the chapter, and the opening lines of the chapter do not account for it. However, the inclusion of this sub-class of cases of natural priority seems a necessary addition for there are relations that although they do not satisfy the condition of non-reciprocation as to implication of being they display a relation of natural order in the sense that the prior items are causes of the posterior ones.

[112] Does the genus/species relation fall under box 2.a or 2.b? Are genera causally related to their species in some sense or not? The text is silent since it does not sub-divide things that do not reciprocate as to implication of existence, into those that are causally related and those that are not.

Relations where	A & B reciprocate as to implication of existence	A & B do not reciprocate as to implication of existence (A entails B but B does not entail A)
A is the cause of B	1.a A prior to B	2.a A prior to B
A, B are not causally related	1.b A simultaneous to B	2.b A prior to B

(*Table 3*)

7.1. Incompatibilities in the accounts of natural priority in *Categories* and *Topics*

In the *Topics* genera and differentiae are prior to their species because they are entailed by them. In *Cat.* 12-13, this kind of priority is labeled priority in nature, and more specifically priority in the order of being. However, in *Cat.* 5 Aristotle distinguishes primary individual substances from secondary substances, species and genera, by saying that among secondary substances 'the species is more of a substance than the genus, since it is nearer to the primary substance.' (*Cat.* 5. 2b7-8). So this is yet another sense of priority, priority with respect to substance, according to which it is the species which is prior to the genus. Does this priority put pressure on the claim that genus is naturally prior to its species? I will first compare the notion of priority in *Cat.* 12-3 to that between genus and species in the *Topics*, then I will examine whether there is an inconsistency between the claims about genus and species in *Cat.* 12-3 and 5.

There is an ambiguity concerning the exact way in which the relation of natural priority relation can be understood. The example in ll. 15a6-7 reads thus: οἷον ἐνύδρου μέν ὄντος ἔστι ζῶον, ζῶου δε ὄντος οὐκ ἀνάγκη ἔνυδρον εἶναι. Some translate thus: if the species 'aquatic' exists, then so does also the genus or 'animal'; but granted the genus exists, there is not of necessity the species.[113] On this reading if the sub-genus aquatic exists then so does the genus animal, while the opposite is not true. Another possibility is to understand the ἔστι not as existential but as copulative, thus trnaslating: if something is aquatic then it is an

[113] This is Cooke's translation. Aristotle, *The Organon*, vol. I, (*The Categories*, *On Interpretation* translated by Harold P. Cooke), 1938 (London: William Heinamman Ltd).

animal; but if something is an animal it is not of necessity aquatic.[114] That is if the ontological predicate aquatic is truly predicated of a subject then the ontological predicate animal is also truly predicated of that subject, while the opposite does not hold. The former reading can be analysed in terms of the latter. Is it though the one Aristotle intends? It can be argued that it is by considering what each reading entails for the priority between genus and species. The ambiguity leaves open two possible formulations of the priority relation between the two:

(a) for any two entities *a* and *b*, if the existence of *a* entails the existence of *b*, while the opposite does not hold, *b* is naturally prior to *a*. (let us call this reading intensional)
(b) for any two predicates *a* and *b*, and for any subject *x*, if *x* is *a* entails that *x* is *b*, while the opposite does not hold, *b* is naturally prior to *a*. (let us call this reading extensional)

The application of criterion (a) yields different results from the ones found in the *Topics*, regarding the genus/species relation. In particular it yields the controversial if not absurd claim that the genus can exist independently of whether any one of its species does.[115] I take this to favour reading (b). According to (b) if a subject falls under the kind fish of the genus animal, it falls, necessarily, under the genus animal, while the converse does not hold. This reading does not commit Aristotle to the claim that the genus exists without its species existing, or to the claim that something can be an animal *tout court* without falling under any species of that genus. So this is a more natural understanding of the priority relation between genus and species both in the *Categories* and the *Topics*.

But, there is a further reason suggesting that reading (b) is preferable to (a). Namely that the latter makes natural priority in *Cat.* 12-13 incompatible with the priority introduced in *Cat.* 5. According to chapter 5, the reason why a species is more of a substance than the

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[114] This reading is in accordance with Ackrill's rendering: 'if there is a fish there is an animal, but if there is an animal there is not necessarily a fish.' (1963:ad loc.)

[115] Any genus could have existed even if none of its species was. Cleary reads the passage in this way and thus takes the passage as evidence for Aristotole's Platonism in the *Categories*: 'this example [concerning the genus animal and the species fish] leaves the distinct impression that a genus (e.g. animal) might exist by itself independently of any particular species of that genus. When formulated in this way, we can recognise it as a claim about the ontological priority of the genus, which Aristotle seems to reject in the *Metaphysics*.' (1988:25).

genus, (2b17-21) is that while the species is a subject for its genus the genus is not a subject for its species. This entails a priority relation between them. If priority in being, in *Cat.* 12-3, is understood according to (a), then the relation between genus and species is a priority of the genus as a separate entity over the species as a separate entity. And this is exactly the opposite claim from the one made in *Cat.* 5. Further, if the two chapters treat the same priority relation while proposing that the priority runs in opposite directions, then there is inconsistency between earlier and later chapters of the *Categories*.[116] Nevertheless, the priority of the genus can be understood according to (b) thus: if a species, *s*, is an ontological predicate of a subject, *x*, then this entails that the genus under which *s* falls is an ontological predicate of *x*. Understood in this way the priority of genus over species, in *Cat* 12-3, is not in conflict with the priority in substance of species over genus, in *Cat* 5. The two priorities are based on the same ontological facts concerning predication. The difference is that in the one case subjecthood is a criterion for priority in substantiality while in the other extension is a sign of priority in nature. This interpretation gets some support from the reason given for priority in substance:

> But as the primary substances are related to other things, so also is the species related to the genus; for the species is a subject for the genus, since the genera are predicated of the species, whereas the species are not reciprocally predicated of the genera. And so for this reason too[117] the species is more a substance than the genus. (*Cat.* 5. 2b19-23)

The priority in substance of the species over the genus is grounded on the claim that the genus is ontologically predicated of the species, and hence it is also predicated of whatever

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[116] This is Cleary's view. He explains the inconsistency by suggesting that chapters 12-13 were written before chapter 5 and argues that their conceptual background is Platonic, as opposed to the anti-platonic, and therefore later, account given in *Cat.* 5. (1988:31)

[117] The first reason is introduced in *Cat.* 5.2b4-14: 'among secondary substances the species is more of a substance than the genus, since it is nearer to the primary substance. For if someone says what the primary substance is, it will be more informative and more ap*propria*te if he mentions the species than if he mentions the genus. It will be more informative, for instance, to say that an individual man is a man than to say that he is an animal, since man is more distinctive of an individual man, while animal is more common; and it will be more informative to say that an individual tree is a tree than that it is a plant.' This seems to contradict the *Topics'* claim that the genus is what is mostly predicated in the what-it-is because when we ask what a thing is the most appropriate answer is to give its genus. However, the context is different. In the *Topics* the claim quantifies over genera and differentiae. Neither species, nor definitions, nor individual substances are included.

the species is predicated, whereas the species is not predicated of whatever the genus is predicated. The same fact provides a reason for the priority in nature of the genus over the species. If the two classifications rely on the same facts about predication, one would expect Aristotle to reject either of the two in the expense of the other.[118] The absence of such a comment suggests that the two classifications are not contradictory. This is possible if we read priority in nature under reading (b).

The criterion for judging whether the genus or the species is more of a substance depends on their extension. The predicate that has a narrower extension is ranked higher up in the hierarchy of substances. This ranking is consistent with the claim that the secondary substance which are hierarchically lower in the order of substance, i.e. genera, are naturally prior to species. First, the criterion of natural priority is not a criterion that applies exclusively to substances, or secondary substances. For natural priority relations hold between non-substantial items. Further, differentiae, which are not paradigmatic substances, are also naturally prior to species. Secondly, the reason why these predicative relations result in relations of natural priority has to do with definition and the ordering of the predicates in a hierarchy that depends on what is more knowable in itself as opposed to what

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[118] Or at least to comment on that incompatibility. Even if we suppose, with Cleary, that *Cat.* 12-3 present Aristotle's earlier Platonistic views while *Cat.* 5 a later development the problem persists, precisely because Aristotle offers no argument, against the early view. The argument for the natural priority of the genus seems to be: (1) the genus is predicated of whatever its species is predicated of and of other thing besides while the species is not predicated of the genus, (2) (from 1) whatever possesses the species also possesses the genus while whatever possesses the genus does not necessarily possesses the species, (3) (definition of priority) what does not reciprocate as to implication of existence is naturally prior, Therefore (4) (from 2 and 3) the genus is naturally prior to the species. The argument for the species being more of a substance than the genus seems to go: (1) the genus is predicated of whatever its species is predicated of and of other thing besides while the species is not predicated of the genus, (2) (criterion of substantiality) when a secondary substance is predicated of another secondary substance as its subject then the subject term is more a substance than the predicate, therefore (3) the species is more a substance than the genus. Both arguments use the same major premise. Then two different principles are applied. If the conclusions are indeed contradictory Aristotle needs to justify how these two principles produce contradictory conclusions from the same major premise, and presumably reject one of the two. However, the one argument does not necessarily block the other. Hence there seem to be no compelling reason to conclude that there is contradiction here.

is more knowable with respect to us.[119] The reason, on the other hand, that the predicative relations between substantial items result in a hierarchy of substances has to do with the criterion of subject-hood. In this latter hierarchy primacy is preserved for those subjects that are not predicated of anything further. This is a different order of priority. Hence, there is no reason to suppose that the criterion of natural priority in *Cat* 12-3 and in the *Topics* are inconsistent with the claim that the species is more of a substance than the genus it falls under.

7.2. Priority relations and predication between the terms in a definition in the *Topics*

According to the above interpretation, the relation of natural priority between the parts of definitions is cashed out in terms of the predicative relations between these terms. Genus, differentiae and the species defined by means of them are related in the following way:

(a) the item that occupies the genus position in a definition must have a wider extension than the item that occupies the differentia position; and
(b) the item that occupies the differentia position must have a wider or equal extension to the item that occupies the species position.

(a) and (b) are not equivalent to the stronger claims (a*) genera can exist without the differentiae or species; (b*) differentiae can exist without the species, but to the weaker ones:

(a**) the genus is predicated of all the items that possess, or are characterised by one of its differentiae, and
(b**) the differentia is predicated of, at least, all the items of which a definition composed by this differentia and the genus under which the differentia falls is predicated.[120]

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[119] A similar hierarchy seems to be present in *Physics* I.1. where the more specific concepts, what is prior in substance according to *Cat.* 5, is a starting point to ascend from what is more known to us and less known by nature to what is less known to us and more known by nature. What is more known by nature is the definition when compared to the *definiendum* and the same holds of the properties included in the definition (*Phys.* I.1 184b1 ff.), i.e. genera and differentiae. If genera and differentiae are better known by nature than the species they define, they are naturally prior to the species. This does not mean that the *Physics*, generally thought of as a late work, rejects the subject-hood criterion for substances. Thus, it seems that the two hierarchies are compatible, because they deal with different aspects of Aristotle's ontology.

[120] This understanding of natural priority is close to the way we define class-inclusion. A genus is said to be prior to its species because the extension of the genus includes the extension of its species. The sense of priority employed here is one that holds between two predicates, *p1* and *p2*, such that, if *p1* is prior to *p2* then *p1* is necessarily predicated of, at least, all the subjects *p2* is predicated of.

For instance, suppose the species man is defined by means of the genus animal and the differentia biped. The predicate animal must be wider than the predicate biped in the sense that some animals do not possess the quality of being biped. Those animals possess some contrary differentia of the genus, e.g. being quadruped. The differentia, on the other hand belongs at least to all the items to which the definition applies and it is predicated of them in the first figure of predication (though it may belong more widely).

It must be noted that the priority relations between genera, differentiae and species offer further support to the extensional interpretation of natural priority for the following reason. Aristotle holds that in this series of predicates with successively narrower extensions, the genus or its sub-genera are not predicated of the differentiae that divide them, although the differentiae themselves are predicable of categorically lower items. They are predicated of the species they divide. For instance, animal is not predicated of biped while biped is predicated of man. This does not pose a problem for the extensional reading of natural priority. For on this reading priorities between genera, differentiae and species, are not merely grounded on the predication relation between those predicates. They are grounded on a comparison of their extensions.[121] By contrast the intensional interpretation reads the priority with respect to being as claiming that an item is prior to another if the latter item is necessarily predicated of the former. Clearly this is not the case between genus and differentia, for genus cannot be predicated of the differentia, and yet the genus is naturally prior. This difficulty suggests that the extensional reading is the preferable one.

8. Natural Priority

The priority relations between the definitory terms follow the order of natural priority. Aristotle is not claiming that what is naturally prior exists independently of whether what is naturally posterior does. He makes the weaker claim that when the prior term is not present

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[121] In other words, the genus is prior in nature to the species not because it is predicated of it, but because it is predicated of whatever the species is predicated of necessity. Similarly the genus is

in a subject nor is the posterior present in it.[122] This is, one way of understanding non-reciprocation as to implication of existence as a sufficient condition for natural priority.[123] Definitory parts satisfy this condition.

Non-reciprocation as to implication of existence is not identified with natural priority in *Cat.* 12. It is introduced separately and treated as a distinct kind of priority. Nevertheless, it was suggested that natural priority is wide enough so as to cover the priority in the case of things that do not reciprocate as to implication of existence. This suggestion holds if either (a) the division of senses of priority in *Cat.* 12 is not exclusive but inclusive and/or (b) natural priority is a blanket concept that applies to different senses of priority treated in this chapter.

The division seems to be inclusive because the priority introduced at 14b11 ff. answers both priority in nature and priority in the order of being.[124] But even if the inclusive nature of the division is contested there is indication that the concept of natural priority functions as a blunket term. Priority in nature is introduced as a 'manner of priority besides those mentioned', which might mean a manner of *natural* priority besides those mentioned. At least one other case of natural priority was mentioned earlier in the chapter: 'besides the ways mentioned, what is better and more valued is thought to be prior by nature; quite ordinary people are wont to say of those they specifically value and love that they 'have priority'.' This sense of priority follows from evaluative judgments, but no criteria are offered on which these value judgments rely. Priority relies heavily on the way priorities are

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naturally prior to the differentia because it is predicated of whatever the differentia is predicated of necessity (and not because it is predicated of the differentia).

[122] But why is this priority a case of *natural* priority? The reason for the priority relations is that the prior entity has a wider denotation than the posterior one. One possible reply is that this ordering is an ordering according to nature, the predicative relations are dictated by nature. But this still seems fairly obscure.

[123] A further sufficient condition that grounds priority in the sense of non-reciprocation depends on a causal relation between the terms that do not reciprocate.

[124] This sense of priority is introduced thus: 'There would seem, however, to be another manner of priority besides those mentioned. For of things which reciprocate as to implication of existence, that which is in some way the cause of the other's existence might reasonably called prior by nature.'

perceived in everyday life. Since Aristotle usually contrasts nature to human activity, it comes as a surprise that his main examples for priority in nature come from the realm of human activity, instead of nature. One wonders to what kind of priority does the qualification 'natural' contrasts. It is not contrasted with priorities set by human decision, emotions and actions. Nor is it contrasted to any of the other senses of priority. To the contrary the priorities seem to flow from an order of things imposed by nature. So perhaps natural priority has a very wide application, and the sense introduced at 14b3-6 is just one way the concept is applied. Perhaps a general and vague one but also one very familiar to us. This vague sense of priority familiar from common experience can offer an initial grasp of the concept of natural priority. Then the more specific notions of natural priority elaborate from this primitive way of understanding priority. A closer examination will reveal other, more specific cases.

According to this line, Aristotle begins with an everyday conception of priority from which he extracts the notion of ranking things in an orderly way as prior and posterior with respect to what is more valuable or more basic. Then this wide notion of natural priority is used as a label for relations where there is a similar structure, i.e. where one thing is more basic than something that follows from it, or is dependent on it, or is its cause.[125]

(14b11-14, Ackrill's tr.) This sense covers both cases of natural priority, and cases of priority in the order of being.

[125] Alexander's examples also suggest that natural priority is wide enough, so as to include all sorts of different cases: substance, he says, is prior to the other categories; unit is prior to number; nutritive soul prior to the other kinds or parts of the soul. None of the prior items in this list is the genus of the posterior ones. Nor the *relata* correspond to any one of the senses of priority Aristotle sets out. This suggests that natural priority can be conceived as a wide notion. In these examples the prior items are prior because they are more basic in some way, and this is a general characterization of natural priority. It should also be noted that the prior items in these examples are more basic, not because they can exist independently of the posterior items. For instance, the items that fall under the category of substance are naturally prior to items from the other categories, in the sense that if substances did not exist nor would non-substantial items, not in the sense that substances could have existed without any non-substantial attributes whatsoever. The same holds between the nutritive soul and the other parts of the soul. Nutritive soul is prior not in the sense that it can exist independently from other parts (the cases in question here are obviously cases of living things whose soul has more parts than just the nutritive, for in cases of living things where there is only a nutritive part, there is no posterior part to it).

Further, this understanding of natural priority may indicate one way in which the link between the ontological order of what is naturally prior, and the epistemological order of priority between what is more knowable by nature and what is more knowable to us, can be understood. Natural priority is first treated in terms of some order which is familiar to us. However, natural priorities are ultimately grounded on reciprocation as to implication of existence and causal relations. The latter kind of relations although less familiar to us they are more knowable by nature. So ultimately the order of natural priorities is one and the same with the order of intelligibility. This order of natural priority is one criterion that helps grounding the distinction between definitory and non-definitory predicates.

There are further ways natural priority is determined. And the one that relates to explanatory considerations will become pre-eminent in the *Analytics*, as well as in the scientific works where Aristotle focuses on the natural priority of definitory or essential predicates of a subject as depending on their explanatory or causally basic role vis-à-vis further predicates. To such *aitiological* criteria we shall turn in ch. 4-5. But first let us make sense of the lessons that can be drawn from the *Topics*.

9. The distinction between essential and non-essential predicates

Aristotle draws, in the *Topics*, a severe distinction between essential and non-essential necessary predicates or properties of a subject. Yet no obvious necessary and sufficient criteria are offered for this distinction other than his notion of being predicated in the what-it-is. His brief methodological remarks on the study of differences and similarities may offer some assistance in following the distinction between the two kinds of predicates when defining, but they do not constitute a substantial defense of it. What kind of justification these considerations offer?

As it was argued above the demarcation of predicative relations in the first figure of predication, is what underlies the division of the predicables into those that are definitory or essential and those that are not. However, Aristotle gives no clear indications on why should

we draw such a distinction or how the distinction between different categories of predication must be drawn.[126] So the distinction between definitory and non-definitory features is not the only one for which no clear criteria are spelled out. The division of categories of predication on which it is based is not justified by such a set of criteria either (even if the list is not intended to be an exhaustive one). It rather seems to rely on some basic intuitions. Namely, first, on how to distinguish between ontological subjects and predicates, and, secondly on how to distinguish between two general kinds of ontological predication: (a) predicative relations where the predicate signifies what the subject is and (b) relations where the predicate qualifies the subject in some respect or other.[127] If these distinctions rely one some intuitions about predication, why should intuitions be any worse, at least as a first grasp, with respect to the distinction between what is essential and what is not? Further, since the distinction between predicates under (a) and predicates under (b) supports the distinction between predicates that are essential to a subject and those that are not, if our intuitions concerning predicative relations are sufficient for yielding a grasp of different kinds of predications, they should also suffice for at least an initial grasp of the essential/non-essential distinction.

The suggestion is a close association of the priority relations between kinds of predications and priority relations between different kinds of necessary features of a subject. A similar view has been suggested by Mansion. He notes that the only criterion for distinguishing what is essential from what is not is that essential, and hence definitory,

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[126] Frede observes that these questions are left unanswered: '...our understanding of what the categories are supposed to be would be greatly increased if we had a better understanding of why Aristotle thinks that we have to make this distinction, of how he thinks it is to be made. Unfortunately, Aristotle in the *Topics* does not enter into a discussion of these questions.' (1987:47) Frede's suggestion is that 'it may very well be the case that Aristotle thinks that it is sufficiently obvious from the practice of the kind of dialectical discussion which is the subject matter of the *Topics* that we have to make that kind of distinction of predications.'

[127] It might be argued that Aristotle has a criterion on which he bases his distinction between (a) and (b). Namely that a predicate is truly predicated in the what-it-is of its subject iff the definition of the predicate is truly predicated of that subject. However, this cannot be an independent criterion. For judging which predicative relations fall under the first figure if definitions are formed by means of collecting the predicates that are predicated of a subject in the first figure predication.

features signify what an object is. (102a32-34) He suggests that the difference between what an object is, i.e. what constitutes that object, and the features of that object has an immediate sense for our minds.[128] The former category of predicates constitutes the first category of predication of *Topics* I.9, which includes terms that refer to the subject and signify what it is, such as the genus-term the species-term or the definition that apply to a subject.[129]

It is interesting that the reference to genus-terms, species-terms and definitions in I.9 points to the kinds of sameness distinguished in *Top.* I.7, namely sameness in (a) genus, (b) species and (c) in number.[130] Predicates under (a) or (b) point to a similarity between subjects that differ in number. The stricter case of sameness under (c) applies to a subject and its definition, while in a secondary sense the relation between a subject and its *propria* or even its accidents may also fall under it. In other words predicates in the first category of predication point to strong conceptions of sameness. This may not be an explanation of

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[128] Mansion draws on the similarity between the 'logical' distinction between predicates predicated in the what-it-is and those that are not, with the 'ontological' distinction between the categories. The division of the categories is based on the distinction between a subject such that it cannot be said of any other subject, and the ontological accidents of a subject which are predicated, ultimately of subjects of the former kind. But these latter predicates are themselves divided into two kinds of predicates, namely those that are predicated in the what of their subject and are identical to their subject and those that are not identical with but they imply the existence of such a subject. The latter category of things corresponds to ontological accidents of substances, i.e. to items in non-substantial categories. Therefore, Mansion concludes, in the case of the category of substance the ontological distinction between what is predicated as an ontological accident or not corresponds to the logical distinction between non-essential and essential properties. In effect the latter logical distinction becomes an ontological one. Aristotle certainly extends this doctrine to the non-substantial categories in *Top.* I.9, though he has reservations in *Met.* VII.4 1030a20-25; VII.5 1031a1-4. Mansion ultimately argues that as abstraction can ground the division between substance and non-substances, the division between essential and non-essential predicates can be reached by the same procedure. (1946:50) Mansion writes: est substance le sujet dernier d' attributtion qui ne peut se rapporter a un sujet distinct de lui-meme. Ce qui au contraire s' attribue a quelque sujet est une accident (ontologique); il en resulte que les predicats qui signifient une ubstance signifient la meme chose que le sujet auquel ils sont attributes, puisque la substance ne peut etre prediquee d' autre chose: ils en expriment l' essence ou une note essentielle (I.22 83a24-5; 83a39-b1) (1946:47).

[129] See 103b35-7; *Met.* VII.4 1029b13-9. Mansion says that the second kind of predicates refer to their subject without representing this subject. (1947:47)

[130] The three uses of sameness are introduced at 103a8-9. Sameness in genus and species are the result of essential predication. Sameness in number, 103a23 ff., is sub-divided into a number of uses, including cases where an accident and its subject are said to be the same. (103a29-31) The stricter sub-use of this sameness is 'when that which is the same is indicated by means of a word or a definition.' (103a25-6)

predication in the first category, but indicates that Aristotle might think that differences with respect to the way a predicable determines its subject are immediate.

The above suggestion concerning the intuitive plausibility of the distinction between definitory and non-definitory predicates is not necessarily in tension with the close connection of this distinction with *aitiological* considerations that prevail in the *Analytics*. It does not contradict the claim that essential features have an explanatory role to play over non-essential necessary ones. Rather the way essences are used as middle terms in the appropriate syllogisms explaining further features of their subject, may indicate a process that specifies more accurately the essence of the subject and vindicates some initial intuitions concerning it. Still a preliminary grasp of the essence of a subject, and most pre-eminently of the genus, is possible without a full account of the explanatory powers of all the elements in the essence.[131]

This view invites the following objection: if it is possible to define a subject by means of less accurate or less basic characteristics it must be possible to define it by means of its non-essential necessary properties.[132] The question can be put thus:

(1) If the essence is conceived in such a weak sense that not only the most fundamental characteristics but even some less basic ones are included then does this not undermine the distinction between essential and non-essential properties?

Two considerations suggest a negative answer. First, both in the *Topics* and the *Analytics*, Aristotle insists on the importance of the genus as a necessary part of that initial grasp. One must begin from the 'most' essential predicate, and proceed to formulating the definition.[133]

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[131] In other words it is not necessary to arrive at a network where all the necessary features of a subject are laid out in scientific syllogisms where they are explained by essential elements as middle terms. Mansion writes: 'En disant que l' intelligence atteint l'essence des choses dès qu'elle les connaît on ne prétend pas qu'elle possède d'emblée une connaissance parfaite de leur quiddité. On veut seulement souligner que l' intelligence ne manque pas son objet qu'elle l'atteint donc en lui-même, quoique cette appréhension puise être très confuse et perfectible en un large mesure.' (1946:54)

[132] Mansion (1946:55).

[133] Even if (1) is answered in the affirmative because one holds that the aitiological criterion is sufficient in drawing the distinction between what is part of the essence and what is not, still, along with this strong conception of an essence there must be a weaker one. Similar to the one implied in the negative answer to (1). The reason is the fact that the explanatory force is not an all or nothing

This places a constrain both to the differences between the subjects that one seeks as well as the patterns of explanations one is looking for.

The second consideration for a negative answer to (1) has to do with the possibility that the distinction between essential and non-essential predicates may not be in fact as clear-cut as the question assumes. Some examples, especially in biology, imply a gradation between the explanatory role of features of living things, that makes it difficult to draw a line between the two kinds of predicates. Some may refer to plainly non-essential features, e.g. the capacity of humans for learning *x*. Some may have an intermediate explanatory role, e.g. some differentiae of animal parts which explain lots of other features in the organism, and yet they are explainable by more basic features. Still some further features will constitute the 'core' essential ones, without necessarily explaining all other necessary features. [134]

To summarise, the distinction between categories of predication, and hence between categories of predicates, seem to constitute a primitive division. It is based on some intuitions concerning predication, including the thought that among the predicates of a subject predicates signifying what the subject is are prior to predicates qualifying the subject in other respects.[135] The same set of facts regarding predication underlie the distinction between what is essential, i.e. predicated in the what-it-is, and what is not. These general considerations concerning predication may not be sufficient for determining fully the

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concept, and different features of the entity will differ with respect to their explanatory power. This is also supported by the view that there is no one single essential feature which is the ultimate indemonstrable middle term that underlies the scientific demonstrations of all necessary properties. (although perhaps such an explanation is possible in definitions of simple events such as eclipse or thunder). This claim is suggested by explanations the biological works.

[134] A further reason: although there is a basic distinction between predicates expressing what a subject is in itself and predicates expressing a characteristic this subject possesses, a definition, D_1, consisting of the latter kind of properties would imply a certain apprehension of the object. Again this need not be, and it is not, true of all necessary predicates of a subject. Some of them, such as differentiae, may be more privileged than others. It seems that the ambivalence concerning the status of differentiae reflects this point. On the one hand, they qualify the genus in certain respects. On the other, they give some grasp of the nature or essence of the subject; a sound division of the differentiae is a pre-requisite of the search for what explains them.

[135] The thought that the ultimate subjects of predication are ontologically prior to all other items, must also be included here. According to Frede this is the primary reason why in the *Metaphysics* the

distinction between what is essential and what not. The *aitiological* structure would establish the essential facts. Nevertheless, it is not clear whether the search for such explanations can be conducted before the subject-genus is fixed and its characteristic kind of priority is at least vaguely determined. The kinds of explanation to be sought, and the nature of the priority relation vary from one subject-genus to another. For there might be different sorts of explanatory patterns prevailing inside different genera.[136] If so it seems plausible to maintain that at least some of the *Topics*' injunctions and the *Analytics*' emphasis on explanation and the middle terms of syllogisms are not necessarily features of two competing models. If certain features from the *Topics* still play a part in the *Analytics* method the two accounts need not yield contradictory results.

10. Conclusion: The *Topics'* assumptions

Let us summarise the points that can be extracted from the *Topics* with respect to definitory predicates and the formulation of the definition of a subject.

The first thing to note is the importance of the study of differences and similarities as a comparative study that aims at definitions of subjects of the same genus. This is the way to proceed for collecting their non-accidental attributes and formulating their definitions. Given collections of these attributes, a list of corresponding premises can be compiled. This list could be used for searching for the corresponding explanations and forming demonstrations, thus forming the body of knowledge under the corresponding scientific discipline.

The second thing to note is the pre-eminent role attributed to the genus over the differentia of the *definiendum*. The genus is the most important element in the definition,

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what-it-isis restricted to substances, e.g. *Met.* VII 1028a10 and Z.4 1037a17 ff. (1987:45) This is not immediately relevant to the present discussion.

[136] For instance, the subject-genus of metereology including phenomena such as eclipses will rely on essences that are efficient causes. Mathematics, on the other hand is foreign to considerations about efficient causation. Biology takes into account teleological considerations, that determine what

and locates the subject under a category of being, and, more importantly under a more specific tree of divisions (e.g. living thing or plant and so on). Locating a subject under a genus implies some constraints. First it limits the number of predicates that could refer to necessary features of that subject. Secondly it limits the predicates that can be selected as the relevant differences and similarities between this subject and other co-generic subjects. Further, this way that the genus constrains the scope of the essential characteristics that belong to a subject, implies that the genus plays some explanatory role. And this implies that the view concerning the pre-eminence of the genus in definitions is not necessarily at odds with the development in the *APo.*, where explanation becomes the most important factor in definitions.

Thirdly, necessary predicates of a subject come in a series of priority relations, where what is prior by nature is prior also with respect to intelligibility, while what is posterior by nature is also posterior in intelligibility.[137] Although no explicit criteria are set out for demarcating what is more or less knowable by nature, it seems that, in the *Topics*, the more generic a predicate the more knowable it is in the order of unqualified intelligibility. This follows from the pre-eminent role attributed to the genus of a subject in defining or giving the essence of that subject, which is the primary element in a definition. Accordingly the differentiae by means of which the genus is sub-divided should be less knowable than the genus but more knowable than the lower and more specific attributes in the division. Undoubtedly this picture is modified in the *Analytics* where the order of priorities takes account of explanatory or causal relations. But I will try to argue that it is not modified in a way that entails the rejection of the order of priorities displayed in the *Topics*.

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kind of predicates are prior by nature or what predicates answer the 'what is it?' question in the relevant way.

[137] The knowledgerelations here concerns unqualified intelligibility. This form of knowledge is equated with the exact and complete knowledge of a discipline. When Aristotle talks about the order of knowledgewith respect to us, i.e. the non-experts, the order of priorities is reversed. What is more knowable to us, i.e. to learners that do not master the subject-genus, is standardly equated with what is

These three elements point to the importance of the method of dividing a subject genus in forming definitions of its subjects. Searching for these definitions involves searching for the relevant genera and differentiae, which when put in the right order can successively specify, and ultimately accurately define the nature of the subject.[138] The *Topics* do not offer any clear-cut necessary and sufficient criteria for picking out essential properties. However, they offer evidence that one should proceed in the following manner. First a number of subjects must be grouped under a common genus. Then predicative relations are collected by studying the differences and similarities of those subjects, and some tentative definitions can be formulated. The attributes collected in this way must fall under the genus examined and satisfy certain constraints that can be tested through the corresponding *topoi*.[139] Finally, the proposed predications and definitions, are either overthrown or accepted as true definitions.

To summarise, the only instruments provided by the *Topics* in the 'hunt for definitions', are, first, the distinction between figures of predication that implying a division between essential and non-essential predicates, and secondly, a set of *topoi* for testing whether the predicative relations or definitions put forward satisfy some necessary criteria of priority. These criteria imply a gradual ranking of the essential attributes with respect to generality and intelligibility, thus forming an initial division of the common genus under which the examined subjects fall. These elements reappear in some form in the *Posterior Analytics* and

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less knowable unqualifiedly. So we start from what is more knowable to us and less knowable by nature and move toward what is less knowable to us but more knowable by nature.

[138] The tests put forward in the *Topics* for correcting or establishing predicative relations under the first figure of predication point to this direction. The *topoi* that relate to definition or its parts are ultimately ways of putting into the test the predicative relations between subject and attribute, through their relations to further subjects and attributes, either generic or more specific.

[139] It may turn out that the attributes do not constitute a full list of the attributes obtained by a full division of the genus, or that they are not arranged in the correct order. Further it may be that the attributes gathered in the beginning of the study are those that are more knowable to us. As the study progresses one grasps attributes that are more knowable unqualifiedly.

the biological works.[140] However in both these contexts new issues arise, demanding refinement of these views, and new concepts are introduced. Most pre-eminently the notion of *aition* (explanatory factor, or ground), which is absent in the *Topics*. In the *Analytics aitia* are linked to the middle terms in scientific syllogisms. Considerations with respect to this kind of priority become pre-eminent for dividing between essential and non-essential predicates, and therefore for forming definitions.

[140] The same is true of the three elements mentioned above, namely the study of differences and similarities, the importance of the genus in the process of defining, and finally the order of unqualified knowledge inside the subjects genus which the of that genus should follow.

1. Introduction

The *Topics* account of the predicables relies on the distinction of definitory predicates of a subject from predicates that denote necessary, yet not essential properties of the subject.[141] The *Topics* do not offer clear-cut criteria distinguishing between the two kinds of necessary predicates, essential and non-essential ones, other than the criterion of predication in the what-it-is. Further, it seems that the *Topics* implicitly assume that given this criterion and a method for discovering differences and similarities between subjects that will follow the order of natural priority one can pick out the definitory parts and formulate their definitions. In the following two chapters I will turn to the *Posterior Analytics* in order to examine the way these assumptions are developed and refined. In examining the relevant passages from the *Analytics*, especially II.13, I will refer to evidence form the biological works, since, in at least some interpretations, the methodological discussions in the biological books elaborate on the *APo.* views on definition.[142]

The relation between the method outlined and analysed in the *APo.*, and the method followed in the biological works is the object of a long controversy. Some commentators claim that the prescriptions formulated in the *APo.* concerning understanding, or scientific knowledge, do not correspond to the way actual scientific explanations are formulated in Aristotle's natural science. *APo.* presents a rigorous, highly systematized method which is not reflected in the practice followed in the biological corpus.[143] By contrast others claim

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[141] They are also distinguished from predicates that denote accidental properties. I will not deal with this distinction. It does not have an immediate bearing on the discussion of definition and it seems easier to maintain in terms of the following criterion: accidental predicates of a subject are distinguished, from necessary ones (either essential or non-essential) by the fact that they may or may not belong to this subject.

[142] Apart from the methodological discussions, biology offers an immensely rich material illustrating the way Aristotle investigates the nature of living things. This material is instructive for the way Aristotle's methodological principles are put into practice. I will look in more detail to some of this material and the implications concerning Aristotle's views on essence and definition in ch. 8.

[143] Perhaps the most pre-eminent supporter of this view is G.E.R. Lloyd. (1990) & (1991).

that the practice and methodological remarks in the biological works fill in the details of a theoretical science of the natural world left unspecified in the *Analytics*.[144]

My aim will not be to examine head on this controversy as it relates to the wider question whether the scientific works follow the 'ideal of demonstration' and the axiomatic structure laid out in the *Analytics*. Instead, I will focus on the views concerning the distinction between essential and non-essential necessary properties of a subject. This distinction is at work both in the *Analytics* and to some extent in the biological works. I will try to show that some of the discussion in the *Analytics* assumes it or draws the distinction in a rough and general way, without laying down necessary and sufficient criteria in a straightforward manner familiar to the modern reader. Secondly, I will argue that to some extent the distinction is supported by the reasons that motivate it in the *Topics*. In chapter 8 I will argue that the biological works are compatible and include both these aspects. These considerations provide, I take it, one thread linking the method in the logical and biological works.

There are two general interpretative lines of what is supporting the above distinction. Some claim that a sort of intuition is sufficient to reveal to us the nature of an object, thereby allowing for discriminating between the two kinds of properties.[145] According to the second line the essential properties are explanatorily more basic by contrast to the non-essential ones.[146] The former are causally more fundamental than, or the explanatory antecedents of, the latter. The first line has at times been perceived as adding a platonic element to Aristotle's epistemology. It draws some of its support from the controversial and brief

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[144] The large majority of commentators are nowadays sympathetic to this view, and the question concerns the exact relation between logical and biological works as well as the extent of their differences and similarities. Among commentators sympathetic to this view are, to mention just a few, David Balme, James G. Lennox, Allan Gotthelf, David Charles, R. McKirahan. I assume the legitimacy of arguing for the connections between the two bodies of work, where the one seems to specify or elaborate the doctrines outlined in the other, independently from questions concerning their relative dating.

[145] Ross 1949:84-6; Kahn 1981; Irwin 1990:7.

[146] Kosman 1973; Bolton 1987; Charles 2000; Lennox 2002a.

remarks in the concluding chapter of the *Analytics*. The second line draws on the connection between the explanatory role of middle terms in scientific demonstrations, and the role of essences as middle terms. The essential/non-essential distinction is understood in terms of an *aitiological* account, in that the pair essential/non-essential is linked to the pair *explanans-explanandum*. It is equivalent to the distinction between what is derivable and that from which it is derivable.[147] I will follow the latter interpretation and I will focus on some of the evidence for it. Furthermore, I will argue that certain convictions present in the *Topics* are at work within the framework of an *aitiological* determination of essential or definitory predicates. In that sense what follows could be described either as occupying a middle position between the two interpretations, or as complementing the *aitiological* account.[148]

There are at least two general reasons suggesting the *aitiological* reading. First, in the *Analytics*, as Lennox puts it, 'the enquiry into the nature of a kind is closely intertwined with the enquiry why the kind has the proper attributes it has.'[149] Secondly, again in the *Analytics*, non-essential attributes appear in the conclusions of scientific syllogisms. So they are distinguished by their role in demonstrations. These reasons strongly favor the *aitiological* interpretation. This picture can be complemented in three respects.

First, there is a question following from the fact that the essential/non-essential distinction is present in the *Topics* while the *aitiological* criterion is absent. It can be argued that Aristotle's discovery of the syllogism as well as his theory of the *aitia* give him the

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[147] The expressions may indicate a merely epistemological distinction. E.g. my knowledge that these stones will be laid out in this way are derived from my knowledge that there will be a house. However, I intend to refer to the ontological distinction between the house and the stones out of which it is made. The relation between these two levels of priority is discussed in the next section.

[148] In other words, I will argue that there are elements of definitions that are not *aitiological*, if the latter is not understood more widely, i.e. as including any element that has some explanatory power, including the genus. My strategy will be to press the *aitiological* interpretation in a way that will allow for the inclusion of some of the elements found in the *Topics*' account.

[149] Lennox continues: 'Basic definitions, which are among a science's first principles, are statements of the cause(s) of attributes belonging to their subject. There is no mystery about how the distinction between a proper attribute of thunder –noise- and a definitional attribute –quenching of fire- is made. It is based on our recognition that one feature is a causal consequence of another... They [non-essential properties] are not distinguished from 'essential' properties in virtue of some

resources for a more robust account of the *Topics'* distinction, and suggest new criteria for it. But this leaves open the following possibility. The criteria derived from the *Topics*, need not be incompatible with the *aitiological* interpretation.[150] I will argue that this is the case in the *Analytics* account.

The second point concerns the claim that what is explanatory more basic has a better claim for being included in the essence of a subject. If this is a necessary and sufficient criterion, then all non-essential features must be ultimately explained by appealing to essential ones. However, it may turn out that this is not the case for every non-essential feature, and this raises doubts concerning the necessity of the criterion.[151] Further, even if every feature could be ultimately explained in this way, there would be a gradation between features which are closer or further removed from the essence of the subject they belong to. If (a) being explanatorily more basic is subject to degrees and (b) essential features are distinguished because they are explanatorily more basic, then 'essentiality' comes in degrees.[152] And this raises doubts about the sufficiency of the criterion.

This leads to the third point, namely the claim that necessary predicates always appear in the conclusions of syllogisms while essential predicates always appear as middle terms. The generality of this claim, or even its necessity, can be doubted if some essential features are explanatorily more basic than others. For then some essential features will appear in

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epistemological distinction between two forms of cognitive access; the distinction emerges in the process of discovering the causal structure of the domain being investigated.' (2002:161-2)

[150] The motivation and the reasons for the introduction of the distinction in the *Topics* are either, implicitly or explicitly, rejected in the later account or somehow accommodated in it. In the latter case an account of essential properties in terms of what is causally basic need not be incompatible with the *Topics* views on the distinction.

[151] For instance, there are material properties that always belong to a subject that are not explained by appealing to its essence. The same point can be made in the opposite direction. It is not certain that all necessary features of, say, humans are derivable from a basic defining feature, e.g. rationality.

[152] The explanations in the biological works suggest such a structure where there is a gradation of the features of an entity. What is explanatorily more basic has a better claim for being part of the nature of an entity. However this nature is construed more narrowly or more widely in different explanations. This is consistent with there being a basic level consisting of the most basic features which is the 'core' substantial nature of an entity. I consider the structure of such explanations in ch. 8.

conclusions of syllogisms. Further, syllogisms are insensitive to facts concerning priority, in the sense that given a subject and two co-extensive predicates that belong to it, the form of the syllogism cannot help us to understood which of the two predicates is the explanatorily most basic one. So the requirement that essential predicates can be placed as middle terms cannot be a sufficient condition.[153]

If the *aitiological* interpretation is complemented in the above respects it has to make room for some additional features. Additional to the causal order implied by the scientific demonstration in a given science. Features that appear in the *Topics* discussion fit that role. I wish to examine whether such features are involved in the *Analytics* discussion of definition. So it may be that these features are not incompatible with the remarks concerning *aitiological* definitions in the *Analytics*.[154] The priority of the essential properties over the non-essential ones may be causal in most cases, but this may not be the only consideration underlying the priorities.

2. Definitions as indemonstrable principles and priority relations in the Analytics

The *APo.* account of understanding, is introduced with identifying the understanding of something, *X*, with knowing the explanation of *X*, and knowing that it cannot be otherwise. This yields a certain structure of priorities that the understanding of a subject-genus must follow. A structure that can be captured by demonstration, but which must start from some

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[153] There is the further difficulty that there are syllogisms where the possession of an essential attribute by a subject term denoting a kind is proved through the genus and thus appears in the conclusion of a syllogism. This does not entail that what is in the conclusion is a necessary non-essential feature of the subject. But this is no serious difficulty if these syllogisms are A-syllogisms.

[154] Aristotle seems to incorporate both kinds of criteria in his *Analytics* account. I believe it is in favor of this reading that it brings the *Analytics* account closer to some remarks in the biological works. By contrast, if the *Analytics* rely solely on strong *aitiological* criteria, then an account should be given of the fact that this strong *Analytics* 'ideal' fails to materialise in the biological works. It is often held that the complex phenomena of the natural world resist the tight picture offered in the *Analytics*. As a result of this tension Aristotle is watering down the criteria laid out in the latter work. But if this is not the only way to read the *Analytics* then there is no need to endorse this view. How big a rift there is between the two works depends on how strongly one is prepared to read the *Analytics* account. Read strongly they suggest a disagreement both with the earlier account of the *Topics* and the later of the biological treatises. However, a case can be made for viewing these works as

indemonstrable principles. The priority of the most basic terms implies their indemonstrability. Definitions are among the indemonstrable principles of a science.[155] For *each* science there are two kinds of proper items, subjects and *per se* attributes coming under (I) and (III) in the passage below:

For every demonstrative science is concerned with three things, (I) as many things as are posited to exist (these are the genus[156] whose *per se* attributes the science investigates), (II) the common principles from which as primary [the science] forms its demonstrations and (III) the attributes, concerning which [the science] assumes what each signifies. (I.10 76b11-15; McKirahan's tr.)

The claim that the existence of some subjects under a genus can be proved while the existence of some other subjects must be merely assumed indicates a division between primitive and derivative subjects.[157] This distinction can be traced in the following passage:

I call principles in each genus those [regarding] which it is not possible to prove that they exist. What both the primary and derivative things signify is assumed, but it is necessary to assume that the principles exist and prove that the others do. For example it is necessary to assume what unit signifies, and what straight and triangle do, and that the unit and magnitude exist, but it is necessary to prove the rest. (I.10 76a31-36)

If principles in l. 76a35 refers to primitive subjects, then the thought here is that the existence of primary subjects must be assumed, while the existence of derivative ones can be proved. Unit and magnitude are illustrations of primary subjects, while triangle and straight are cases of derivative ones. Magnitude can be used as a genus for defining triangle. The

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suggesting a continuous re-adjustment of Aristotle's views on ontological priority, essence and definition.

[155] Aristotle distinguishes three kinds of principles: (a) axioms, also called theses, that occur in more than one science, such as the law of no contradiction, (b) definitions of the subjects and attributes, which form the subject matter of each science, and (c) existence claims or hypotheses, of the subjects of each science (*APo.* I.2 72a14-24; cf. *Met.* 1005b4-5). Principles under (b) and (c) are οἰκεία, i.e. proper, to each specific scientific discipline. Principles under (a) are labeled common (κοινά). In *APo.* I.10 76a37-41 the definitions of line and straight are given as examples of proper principles. This is not the only possible interpretation. According to one way of interpreting I.2 72a14 ff. there are axioms, definitions and hypotheses which include but are not exhausted by the existence claims. I will follow the interpretation of McKirahan who argues that *APo.* I.2 is consistent with I.10 and posits three kinds of principles thus identifying hypotheses with existence claims. (1992:42-3) Gomez-Lobo claims that chapters I.2 & 10 show no trace of the distinction between nominal and real definition. (1981:31)

[156] The genus here may be a shorthand for the subjects inside that genus. (75a42-75b1, cf. McKirahan (1992:39))

existence of triangle as a kind of magnitude is dependent on the existence of magnitude as its kind.[158] Unit, however, is not related in the same way to other numbers. Numbers may be defined in terms of units, but unit is not the genus of number. So the two examples illustrate two different cases of priority. First, the priority relating a genus to its subordinate species (magnitude/triangle). Secondly, the priority relating a *definiendum* to terms included in its *definiens*, which are thereby prior to it. This points to two ways in which relations of priority may hold inside a genus. In the first case the more general subject inside a genus is prior to more specific ones, while the second corresponds to cases where a subject is prior to another because the second can be constructed or accounted for in terms of the first.[159] Although these cases seem to introduce an ontological and a parallel epistemological priority the relation between these two kinds of priority is not immediately clear.[160]

In I.2 71b20-22 Aristotle posits six characteristics of the principles demonstrative scientific knowledge depends on: they are R(1) true, R(2) primary, R(3) immediate, R(4) better known than, R(5) prior to, and R(6) grounds of, the conclusion. These characteristics fall into two groups since R(1)-(3) are absolute, while R(4)-R(6) relative.[161] Thus conclusions of scientific syllogisms, which as conclusions are neither primary nor immediate, can be used as premises for deriving further conclusions (they can satisfy R(4)-R(6) without satisfying R(2) and R(3)). Let us examine the requirements, leaving aside

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[157] See McKirahan (1992:38), who argues that the existence of primitive subjects entails the existence of derivative ones. (1992:194-5)

[158] This is the priority relation between a genus and the subject falling under it in the *Topics*.

[159] This way of putting it suggests that the first case of priority is a sub-division of the second.

[160] Here is a further distinction between two kinds of priorities noted by Barnes: 'Aristotle's thought contains the irritating imprecision... [that] the relation of depending on may be either the epistemological relation holding between a's knowledge that *P* and the propositions on which it is based, or the logical relation holding between a demonstrated conclusion and its premisses' (1975:98)

[161] Characteristics R(4)-R(6) depend on the relation between a proposition and the conclusion premised on it. [Barnes (1994:98); McKirahan (1992:24)]

R(1).[162] R(2), primitiveness, is regarded as amounting to indemonstrability and immediacy:[163]

[Scientific knowledge] depends on things that are primary and indemonstrable because a person lacking demonstration of them will not have scientific knowledge. For having scientific knowledge of things of which there is demonstration (and not having it incidentally) is a matter of having a demonstration [of them] (I.2 71b26-9)

According to Barnes Aristotle moves here from demonstrability to primitiveness: if there is knowledge of *P*, *P* is either demonstrable or indemonstrable; if demonstrable its demonstration proceeds from some *Q* which is, thereby more primitive than *P*; if indemonstrable, then there is no *Q*, such that *Q* is more primitive than *P;* therefore *P* is primary. The same argument establishes the immediacy of a principle, i.e. R(3). A proposition is immediate when there is no term that can serve as the middle in a syllogistic proof of that proposition. Therefore any primary premise will be an immediate one and conversely any immediate one will be primary.[164] Moreover, since what is primary and immediate is a principle of scientific knowledge, (72a5-8), scientific knowledge is based on primary and immediate propositions. These are principles that are not knowable through demonstration. (I.3 72b18-22)[165] The following passage suggests that this class includes at least the definitions of primary subjects:

This is our view on these things, and we say that there is not only scientific knowledge, but also a principle of scientific knowledge by which we recognize the definitions (ὅροι)[166] (I.3 72b23-25)

So definitions constitute part of what Aristotle classifies under indemonstrable scientific knowledge. Still it is unclear what recognition of the definitions amounts to. McKirahan

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[162] I will not consider the difficulties in understanding R(1). Barnes, (1994:99) and McKirahan, (1992:29) offer two different interpretations.

[163] Barnes views the three requirements, R(1)-(3) as synonymous. McKirahan as equivalent.

[164] At71b27 indemonstrable replaces immediate. It follows that what is immediate is primary since all indemonstrable premises are primary. The same connection is made at 72a5-8.

[165] Aristotle offers an argument against the position that all scientific understanding is acquired through demonstration in *APo.* I.3: '...if you must understand the items which are prior and from which demonstration proceeds, and if things come to a stop at some point, then these immediates must be indemonstrable.' (72b20-22) For the claim that Aristotle's argument fails to block the objection see McKirahan (1992:28).

points forward to *APo.* II.19 according to which indemonstrable immediates are grasped by *nous.* (1992:28) A compatible alternative is that Aristotle refers to some procedure that includes the study of similarities and differences, accompanied by a parallel classification of the subjects of a genus according to some lines of division.[167] The premises collected in this way are dialectically tested by means of the corresponding *topoi*, and this leads to the formulation of some initial definitions, that can then be refined through the process of formulating demonstrations.

This role of demonstration is implicit in the explanation of criteria R(4), (5) & (6):

> [The principles] must be [R(6)] grounds, [R(4)] better known, and [R(5)] prior: they must be grounds [a] because we have scientific knowledge precisely in cases when we know the grounds; [b] they must be prior if they are grounds; and [c] they must be previously known not only in that we understand them, but also in that we know they are the case. (I.2 71b29-33)

[a] explains R(6) and it is a repetition of one of the conditions for scientific knowledge.[168] Re-emphasises the connection between understanding, and thus demonstrative knowledge, and explanation. In [b], the fact that the principles are grounds implies their priority over what they are grounds of. But there is no agreement about the kind of priority explained in [b]. According to Ross [a] and [b] offer support to R(6) and R(5) correspondongly which are two ways of saying the same thing. The explanatory relations are based on some objective relations holding between the terms inside the genus studied. This suggests that (b) supports R(5) as a kind of ontological priority, which is also reflected in R(6). Barnes thinks that [b] explains R(4) and introduces a case of priority in knowledge according to which: '*P* is prior in knowledge to *Q* if knowledge that *Q* requires knowledge that *P* but not *vice versa.*'

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[166] 'Definition' here certainly includes scientific definitions. The meaning and the extension of the term is disputed by Barnes (1994:109) and McKirahan (1992:28-9))

[167] Division is at least one of the ways that yields non-demonstrative knowledge. The criticisms mounted against division as securing knowledge similar to the knowledge obtained from demonstrations, in *Prior Analytics* I.31 46a36-7, are not destined to condemn the use of division but to show that divisions do not yield demonstrative knowledge. [Bolton (1993:202)]

[168] See 71b9-12. The two, jointly sufficient, conditions for having scientific knowledge of a proposition *p* are: (1) to know the grounds/explanation of *p* and (2) to know that *p* cannot be otherwise.

(1994:95) This depends partly on how one understands [c] '[the principles] must be previously known'. It may be understood, (I), as a reference to the requirement of being better known, R(4), or, (II) as an explanation for R(5) as Barnes suggests.[169] If (I) is the case then [b] must explain R(5), and thus the priority in R(5) is not priority in knowledge but rather a kind of ontological priority, equivalent to the one in R(6), and close to natural priority found in *Cat.* 12. But even if (II) is the case and R(5) points to the priority of the principles in knowledge (in the way suggested by Barnes), since it is a kind of priority that follows from the fact that the principles are grounds it must be equivalent to the order of ontological priorities. So R(5) may be ambiguous between natural priority, or priority with respect to being, and an equivalent ordering with respect to knowledge which reflects the former.[170] Understanding proceeds from what is objectively prior towards proving what is posterior in the same order,[171] because the order of unqualified knowledge must reflect the ontological order of the genus, i.e the relations of natural priority in it. The order of understanding or knowledge with respect to a domain, *d*, is dependent on the order of nature or being within *d*. This is also what is suggested in the following passage:

> Things may be prior and better known in two ways: for what is prior in nature and what is prior in relation to us are not the same, nor what is better known and what is better known to us. I call prior and better known in relation to us the things that are nearer to perception, and prior and better known without qualification the things that are farther. The things that are farthest [from perception] are those that are most universal and those that are nearest are the particulars; and these are opposed to one another. (I.2 71b33-72a5)

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[169] According to Barnes (II) has the advantage that it makes clear that requirement (5) points to priority in knowledge. However, this is misleading because what is at stake here is whether (5) points to priority in knowledge or not.

[170] The principles are prior to things ontologically dependent on them, in a way reflected in the fact that they are explanatory grounds for them. Since the order of scientific knowledge of a genus has to conform to these priorities holding in that genus, the two will be equivalent.

[171] Another objection to Barnes' reading is the one suggested by McKirahan that reading R(4) in l.31 makes the discussion anomalous. It is therefore better to understand ll. 71b33-72a5 as dealing with R(4) and preserve l. 31 for R5. However, this may not be a strong reason against Barnes reading. For ll. 71b33-72a5 discuss the close connection between R4 and R5. So it may be that the priority in R(5) is ambiguous. On the one hand principles are ontologically prior because they are explanatory grounds. On the other hand they are ontologically prior because of considerations that relate to knowledge, and knowledge in the sense of scientific knoweldge of a subject genus must correspond to the ontological priorities in this subject genus.

This is an explantion of the priorities with respect to understanding as dependent on natural priorities. The distinction is also found in *Topics* VI.4-5 and covers the priority of a genus over its species.[172] Further, this priority reappears as priority in knowledge in *Met.* V.11:

In another sense that which is prior in knowledge is treated as also absolutely prior; of these, the things that are prior in definition do not coincide with those that are prior in relation to perception. For in definition universals are prior, in relation to perception individuals. (V.11 1018b30-4)

Barnes claims that this priority, in 1018b30-7, corresponds to the priority mentioned in ll. 71b33, i.e. R(5), while R(4) is equivalent to R(5). But as we just saw this interpretation of R(5) is controversial. R(5) may be the result of an order of ontological priorities within the subject genus studied.[173] If so, the use of priority in the *Metaphysics* passage can be R(4). This is also suggested by the fact that the same point about perception is made at I.2 71b33-72a5 where the same condition is used. The only new element here is that things further away from perception and prior in knowledge in an unqualified way enjoy priority also with respect to definition.[174] But this is hardly surprising. Definitions are closely connected both to explanation since they offer an explanation of the *definiendum*, and to unqualified or scientific knowledge. So the above passage just implies that priority in knowledge, R(4), is dependent on the priority of explanatory grounds, i.e. to R(6).[175] Then R(5) suggests that ontological order is what establishes the priority of principles as explanatory principles in R(6). R(5) corresponds to natural priorities in the subject genus.[176]

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[172] The condition that priority in knowledge is dependent on whether something is nearer to perception or not cannot be read strongly as a necessary condition. There is more than one ways to draw the line between what is more knowable absolutely and what is more knowable in relation to us. (*Top.* VI.4 141b36 ff.) What is more familiar to us cannot have a unitary answer. Being nearer to perception or not is only one of these possible ways (although perhaps the most frequent one). Cf. Barnes (1994:96-7); McKirahan (1992:30-1).

[173] Or it may be ambiguously ranging over both the ontological and the epistemological order which is dependent on the ontological one.

[174] This is something expected given that definitions are of universals, not of particulars, (*APo.* II.13 97b26), and particulars are closer to perception than universals.

[175] For if the order of unqualified knowledge accords with priority in definition, and definition is dependent on explanations this suggests that the principles are prior in knowledge because they are prior in the order of explanation, implied by R(6).

[176] If this is right then the order of requirements (4), (5) and (6) must be the following: (6) entails (4) since explanation grounds definitions and definitions reflect the order of knowledge in the

Does *Met.* V.11 offer a use that corresponds to this kind of ontological priority? The only plausible candidate is the use of priority in nature introduced at 1019a1-2: 'other things are prior in respect to nature and substance, i.e. those which can be without other things, while the others cannot be without them.' The discussion of priority in nature here differs from the one in *Cat.* 13. Only one of the two criteria from *Cat.* 13 is mentioned here, namely non-reciprocation with respect to existence. The second criterion, namely priority of an explanation or *aition* to what it is an *aition* of, is omitted. Further, the use introduced here does not address the relation between genus and species, which is present in *Categories*. Instead Aristotle focuses on two further applications of priority in nature: the relation between a subject and what is the subject of, and the relation between potentiality and actuality. It may be that here Aristotle offers a brief account of natural priority and focuses on two new conceptual tools: the criterion of subject-hood, and the potentiality/actuality distinction. At any rate the discussion of priority in nature is incomplete, since the criterion of non-reciprocation with respect to implication of existence yields more results than Aristotle collects. There is no mention, on the one hand, of genera and species and, on the other, of *aitia* and what they are *aitia* of. Yet both are cases of priority in the order of nature or being. If so then the order of priorities implied by R(5) and (6) can be classified under priority in nature.

Definitions as principles of scientific knowledge are non-demonstrable, immediate propositions. They are grounds that explain further facts about the genus studied. This is equivalent to the fact that what they signify is ontologically prior, for they display the order of natural priorities. So definitions as explanations are more knowable unqualifiedly to their *explananda*. They are prior in knowledge where the order of knowledge is conceived as that of an absolute understanding of the subject genus. This explanatory role may be of two

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unqualified sense. Both (4) and (6) entail equivalent priority relations, which are grounded by the order of priority implicit in (5), i.e. priority in being or nature. By contrast, according to Barnes (5) is equivalent to (4) and entails (6) (1994:97).

kinds. First the most general terms are explanatory with respect to more specific ones. Secondly, some propositions or terms ground explanations of further propositions or terms in the sense that they are *aitia*, of some kind, for them.

The discussion of the priority of scientific principles suggests two equivalent orderings of items within a subject genus. The principles of a science, including some of its definitions, are prior ontologically since they are grounds for further items in the discipline, including presumably, some other definitions dependent on them, in particular definitions of secondary or derivative terms. This order is equivalent to an order with respect to unqualified understanding because the latter is dependent on the former. The priority relations displayed in the definitions of a science signify relations with respect to priority in nature or being.[177] Since priority in definition is equivalent to priorities in unqualified knowledge, the latter must also be equivalent to the order of natural priorities inside the subject-genus.

Let us look briefly at the relation between the order of natural priorities that can be extracted from *APo.* I.2 as related to that in the *Categories* and the *Topics*. In the *Categories* Aristotle employs two basic criteria that determine priority: non-reciprocation as to implication of existence, and the priority of an *aition* to what it is an *aition* of, i.e. priority in explanation or *aitiological* priority.[178] The two criteria are severally sufficient for establishing priority.[179] However, the second criterion defines a wider class of

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[177] This explains why priorities in unqualified knowledge are priorities in nature. Priority in nature/being is a key to explanatory and definitional priority and the unqualified order of knowledge follows the definitional order of priorities. This relation between the order of priorities is also explicit in Charles' thesis that the order of causation determines Aristotle's theory of definition. As Charles puts it 'had the order of causation not been connected in this way to the theory of definition, it would be (at least, epistemically) possible for there to be an alternative route to find what is definitionally prior.' (2000:200)

[178] See the discussion of priority in ch. 3. The first criterion is a platonic principle according to *Met.* V.11 1019a1-4. According to Ross Aristotle is referring to some oral utterance of the distinction (1924:317), since there is no corresponding platonic passage. Cleary argues that the distinction is in use in the *Sophist* and the *Statesman.* (1988:45)

[179] The two criteria appear in the *Protrepticus*: 'Prior things are more of the nature of causes than posterior things; for when the former are destroyed the things that have their being from them are

prior/posterior pairs than the first, all of which it probably includes. In *APo.* something close to the second criterion is assumed when the priority of the principles is implied by them being explanatory grounds (*aitia*)[180] of further items. Although non-reciprocation as to implication of existence is not mentioned, cases that satisfy this criterion are included in the class of those that satisfy the former. One example of such a case is the genus/species relation. The genus constitutes part of the explanatory ground for its species, and it does not reciprocate as to implication of existence with them. If so then the remarks in the *Categories* and the *APo.* on priority are consistent. There is an ontological order of priorities, which covers the way in which the more general entities that fall under a subject genus are prior to the more specific ones.

Surely, this is not the only respect, nor the most pre-eminent one, in which explanatory relations hold within a subject-genus. There are explanations grounded on relations of material, efficient, formal or teleological causation.[181] These cases, or a large number of them, on top of satisfying the explanation criterion for priority, they also satisfy the criterion of non-reciprocation as to implication of existence.

The two previous paragraphs suggest that there is overlapping between the two criteria for natural priority. The non-reciprocation criterion is pre-eminent in the *Topics* and the *Categories* as a first criterion for the relations of natural or ontological priority as well as the priority relations with respect to knowledge that follow them. Considerations with respect to explanation offer a further priority criterion that takes center-stage in the *Analytics*. The two criteria are exemplified correspondingly by the two pairs: magnitude/triangle; point/line.

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destroyed, planes when lengths are destroyed, solids when lengths are destroyed.' (fr. 52, p.60.26 Rose tr.).

[180] Cf. 71b10-11; 71b29-31. I do not assume that the word *aitia* is used in the same way in the two works, but only that cases covered by *aitia* in *APo.* are covered by the weaker use of the *Categories*.

[181] The mathematical and geometrical illustrations exemplify one kind of such relations. Two standard pairs of prior/posterior items come from geometry: line/plane, plane/solid. It is an open

Although the former priority relation can be understood as a result of the criterion of non-reciprocation it seems that it is also qualified by a criterion dependent on explanation, perhaps in a weaker sense of explanation. And this suggests that even if the *Analytics* rely heavily on the second criterion, keeping mostly silent about the first, this need not be interpreted as a radical change on the way Aristotle views the order of natural priorities holding inside a subject genus. The compatibility between the two criteria has some bearing on the exact relation between two contrasting forms of definition, definitions by means of genus and differentiae and explanatory definitions. To this issue I shall now turn.

3. Definition, Division and Demonstration in the *Analytics*

Definitions constitute one of the classes of indemonstrable principles. Since some knowledge is not demonstrative, the indemonstrability of definitions does not threaten their knowledge. (72b19) But if definitions are not conclusions of demonstrations how are we supposed to arrive at them? A positive claim is needed concerning non-demonstrative ways of acquiring knowledge. Part of this claim is made in *APo.* II.8 where it is argued that definitions are grasped through demonstrations where the *definiens* appears as the middle term of a first-figure demonstration. I will examine what exactly this claim amounts to and whether it holds of every kind of definition.

This issue is closely related to a tension between the two kinds of definition present in the corpus and in *APo.* in particular:[182] definitions where the *definiens* is composed by a genus and a number of differentiae,[183] and definitions where the *definiens* consists in some

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possibility that the relation between entities signified by more and less general terms is covered by one of the four *aitia*. (cf. the *Metaphysics* VII.12 1038a5-6 claim that equates genus with matter)

[182] The observation is made by several commentators. See J.M. LeBlond (1979: 63-79). For the opposite view see Charles (2000:247). See also Gomez-Lobo (1981:26-7). He labels the two kinds as *topological* and *aitiological* definition. LeBlond himself posits a third kind of definition where the *definiens* is constituted by entities that stand for the material and formal element of the *definiendum*.

[183] The *loci classici* are *Topics* I.5, *APo.* II.13, *Met.* VII. 12, *PA* I. 1-3.

basic causal feature that explains the definiendum.[184] The former kind of definition is connected with division, while the latter with demonstration. Since division, and knowledge acquired by means of it, are contrasted with demonstration, one is tempted to conclude that Aristotle is vacillating between two different if not incompatible types of definition: (a) definition by division yielding non-demonstrative knowledge, and (b) causal definition which is closely connected to demonstrative knowledge.[185]

There have been attempts to reconcile the two supposedly distinct models and unify the two kinds of definition under one model. Most recently, David Charles has argued for the thesis that definitions by genus and differentia and causal definitions are 'integrated parts of one account of definition.' (2000:247) In what follows I will try to focus on the role of division in the construction of definition. I will focus on the elements of the defining practice from the *Topics* that 'survive' in the *Analytics* and follow the line that this process is compatible with the process of finding causal or explanatory definitions. So I will claim that division and *aitiological* explanation (where the *aition* might be a *telos* or efficient cause etc.) are not offering two competing models but are pointing to two complementary stages of the procedure of finding definitions. The two methods are interconnected and the *Topics*' injunctions are refined and integrated in the model of formulating definitions proposed in the *Analytics* and the biological works.

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[184] The *definiens* gives the reason why. This type of definition is discussed in connection with demonstration in *APo.* II.8-10; 16-17.

[185] The evidence offered by the biological works complicates things further. Scientific demonstrations are not explicitly used in these works. Secondly, division is probably modified but the ways in which it is modified are controversial. The claim that there is some form of non-demonstrative knowledge, including knowledge of definitions as first principles, relates to another vexed issue in Aristotelian scholarship, the interpretation of *APo.* II.19 as evidence for what kind of knowledge non-demonstrative knowledge is and how is it acquired. The chapter addresses two questions: (1) what state is it that grasps first principles? *Episteme* or something different? (2) Is knowledge of first principles acquired or inborn? I will not attempt an examination of these epistemological questions here. However the chapter offers some indication that division is a useful instrument in formulating definitions by suggesting a link between non-demonstrable knowledge and induction (*epagoge*). (This is at least part of Aristotle's answer to question (1) above). Since division is linked with induction, the link between induction and first principles, including definitions, allows for the thought that non-demonstrable knowledge of definitions as first principles depends to some extent on division.

I will first consider the *aporetic* chapters II. 3-7 from *APo.* and try to derive some constraints imposed by Aristotle on the method of definition. Then I will consider his positive account, mainly chapters II.8 and 13 as responding to the earlier puzzles.

4.1 The Aporetic chapters I: APo. II 3-4

In *APo.* II.3-7 Aristotle sets out the following dilemma. There are two ways of giving definitions. First, by some sort of demonstration, exemplified by Xenocrates' method, and, secondly by division, exemplified by the Platonic method of division. Neither of the two methods is able to establish the proposed definition. Aristotle demonstrates how the methods fail, thus pointing to a number of points a theory of definition should meet. The positive exposition of his views in the following chapters must be interpreted as devised to meet the complications set out in II.3-7. I will turn first on Aristotle's attack on the claim that definition can be obtained by demonstration, then on his attack on the claim that definition can be obtained by division.

In *APo.* II.3 91a7ff. demonstration and definition are divorced. Aristotle argues that there is no connection between them by means of the following claims:

(1) not everything that can be demonstrated can be defined, (90b2-17) [186]
(2) not everything that can be defined can be demonstrated, (90b18-25) and
(3) no thing that can be defined can be demonstrated (90b28-91a6) [187]

The claim Aristotle is overthrowing is that a definition can appear as a conclusion of a demonstration. For this to be possible there should be something prior to the *definiens* that could be used as a middle term in a demonstration connecting the two terms that appear in the conclusion, namely the *definiens* and the *definiendum.* But this is impossible for their

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[186] The first argument against the claim that demonstrations can prove definitions is the following: (1) what something is is always universal and affirmative; (2) a demonstration is not always universal and affirmative; therefore (3) (from (1) and (2)) not all demonstrations are definitions

[187] The following argument is put forward at 90b25: (1) the principle of demonstrations are definitions and (2) there is no demonstration of the principles, therefore (3) there cannot be demonstrations of definitions. Claim (2) is defended in *APo.* I.3 72b18-33, 22 84a29-b1.

connection must be immediate, thus not allowing for a middle term relating the two.[188] This posits a first difference between definition and demonstration: the relation between the two extremes in demonstrations is mediated by a third term while the relation between *definiens* and *definiendum* is immediate.

However, Aristotle does not argue from this difference, but uses instead the following one: 'every demonstration proves something of something; in definitions one thing is not predicated of another.'[189] This seems puzzling since the *definiens* is predicated of the definiendum.[190] How does this square with the claim that 'in definitions one thing is not predicated of another'? Either the claim is somehow restricted to the relation between the parts of the definiens,[191] or predication here is used in such a way that excludes essential predication, i.e. predication in the 'what-it-is', and thus any predicative relations between the parts of a definition. The former alternative is better supported by the text but it leaves open the possibility that definitions can appear as conclusions of demonstrative syllogisms. The latter alternative gives a better argument, because it blocks this possibility. But is such a reading possible? I think it is if we take the claim that 'in definition it is not the case that one thing is predicated of another',[192] to mean that in the case of definitions it is not the case that a predicate *p* is predicated of a subject *s*, such that *s* points to something completely *different* from *p*.[193] This is also suggested by Aristotle's next argument:

> Again proving what a thing is and that it is are different. So the definition makes clear what it is, and the demonstration that this is or is not [truly predicated] of that.[194] And of different things there are different demonstrations. (90b38-91a2)

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[188] The text of II.3 is not explicit on whether the relation between *definiens* and *definiendum* is immediate or not. But this is implicit, since if there was a middle term, there could also be a demonstration.

[189] The premise is used, in 90b33-37, in an argument supporting (3) above.

[190] This is implied at 90b4. See also Barnes (1994:198).

[191] Barnes and Ross take it thus.

[192] The text in ll 33-4 reads thus: δὲ τῷ ὁρισμῷ ἕτερον ἑτέρου κατηγορεῖται.

[193] This is against Ross's reading. He takes it that the discussion here concerns only the relation between the parts in the *definiens*. Aristotle's examples also seem to favor of this reading. However, according to the *Topics* there are predicative relations between parts of the *definiens*, e.g. between genera and differentiae. Further, if Aristotle argues from this premise then his argument does not block the possibility that the relation between *definiens* and *definiendum* is demonstrable.

[194] Or in Barnes' rendering 'is truly said of.'

What differentiates demonstration from definition is that in demonstration one thing is said of a different thing. So the stress with respect to definition is that in definition it is not the case that something is predicated of something different from it.[195] Predication in the what-it-is is grounded on a partial sameness between the items that are thus related. For the predicate signifies something of what the subject is.[196] Predicative relations in the first figure imply a strong unity between subject and predicate. On this suggestion a definition cannot be the conclusion of a demonstrative syllogism, not because the *definiens* is not predicated of the definiendum, but rather because the *definiens* is not predicated of the *definiendum* as something different from it. The predication relation is not mediated by a third term but it is an immediate connection every subject has to parts of its own essential nature.[197]

If so then the gap between demonstration and definition, in *APo.* II.3 consists in the following difference. In definitions the parts of the *definiens* are not in predicative relations between them such that there is a mediating term grounding their relation, nor, consequently a mediating term explaining their relation. Further, the *definiens* is not predicated of the *definiendum* as something different from it, but rather as something partly the same with it. The case is very different with the terms of scientific demonstrations, where the predicative

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[195] So the point here is not that in definitions there is no predication relation, either between *definiens* and *definiendum* or between parts of the *definiens*.

[196] The uses of sameness treated in *Top.* I.7; *Met* V.6; X.1, depend on predications in the what-it-is.

[197] The above interpretation can also make better sense of the following argument against the claim that everything that can be demonstrated can be defined, in 90b7-17 ((1) above). Predicates such as the predicate 'having the sum of the angles equal to two right angles' [from here on 2R] which is truly predicated of triangle and can be demonstrated in a first figure syllogism do not demonstrate something that belongs to the essence of the subject. Therefore, not everything demonstrated in first figure syllogisms is a definition. Why is it that the predication relation between triangle and 2R is not a definitional one while the predication relation between triangle and having three sides is? The above suggestion can offer an explanation. There are different predicative relations in the two cases. The predicative relation in 'triangle is 2R' points to a different kind of relation, and one that is mediated/explained by a third term relating subject and predicate, while the predicative relation 'triangle is a three-sided-plane figure' points to a different kind of predicative relation and one where there is no third term relating subject and predicate. Thus Aristotle's argument is premised on the claim that demonstrative and definitional connections differ on whether there is or not a middle term connecting the elements in them.

relation between the two extremes is grounded on their respective relation to the middle term of the demonstration.

This picture is confirmed by the objections mounted in *APo.* II.4 against the claim that the definition of a term can be demonstrated. Again what divorces demonstration from definition is the unmediated character of the relation between *definiens* and *definiendum.* Here are the steps of the main argument, in II.4 91a15-35:

(1) Demonstration is proving something, A, of something, C, through a middle term, B.
(2) Definitions are *propria* predicated in the what-it-is of their subject, and therefore convert with it: if $Aa_{def}B$ then A is a *proprium* of B predicated of B in the what-it-is and converts with B.[198]
(3) If we are to demonstrate the definition of C, i.e. that $Aa_{def}C$, then we must do that through a middle term, B, such that $Aa_{def}B$, and $Ba_{def}C$.[199]
(4) But then in proving that A is the definition of C, i.e. that $Aa_{def}C$, we have assumed a different definition of C, namely B which is not demonstrated.
(5) Therefore the definition of a term C cannot be demonstrated.

Step (3) blocks the possibility of demonstrating definitions. The argument may not be powerful,[200] but what is more important is the way Aristotle tries to show that demonstration of definitions is impossible. Suppose *A* and *C* to be the *definiens* and *definiendum* of the definition one tries to prove by demonstrating *AaC*. Demonstration of *AaC* requires, by (1) above, a middle term, *B*, mediating between *A* and *C*. Then (3) demands something stronger, namely that the middle term *B* is related to both *A* and *C* in the way *A* is related to *C*. The middle term's relation to the two extremes must be as strong as the definitory link between the two extremes. Part of the reason for such a constraint is that explanation proceeds from what is an explanatory ground to what it grounds and what is demonstrable by means of it.

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[198] Barnes notes that a definition does not convert with its subject in the sense that if A is the definition of B, B belongs in the definition of A. (1994:209) But, as suggested by Ross, Aristotle may mean that a definition is co-extensive with its subject. The passage here echoes the *Topics* I.5 claim that definitions counterpredicate with their subject.

[199] As Barnes puts it there are four possible combinations of premises (i) $Aa_{def}B$, and $Ba_{def}C$. (ii) $Aa_{def}B$, and not-($Ba_{def}C$), (iii) not-($Aa_{def}B$), and $Ba_{def}C$, and (iv) not-($Aa_{def}B$), and not-($Ba_{def}C$). Aristotle explicitly rejects (ii) in a21-23, but he never deals with (iii) or (iv). And even his reasoning in rejecting (ii) is not clear or, according to Barnes, satisfactory (1994:208).

[200] Barnes finds the argument problematic in a number of ways. The most crucial is that Aristotle blocks the deduction of $Aa_{def}C$ from $Aa_{def}B$ & not-($Ba_{def}C$), contrary to what step (3) suggests (1994:209). Since the passage, Barnes adds, it is a part of 'the preliminary puzzling, we need not be too distressed.'

(91a26-27) The two are, thereby, related as prior to posterior. So *AaB* and *BaC* cannot be weaker than *AaC*. If the latter is definitional the former must also be definitional. Further predicative relations in the what-it-is are prior to predicative relations in any other figures of predication. They may be involved in explaining other predicative relations where something different is predicated of the subject, but no other predicative relation will be involved in explaining a case of predication in the first figure. They constitute the strongest predicative link because they do not predicate something of something different.[201] Therefore, this argument shows that what divides definition from demonstration is that in the former there is a first figure predicative relation, or at any rate a relation that points to the unity between subject and predicate.

So, on the one hand the relation between *definiens* and *definiendum* is a strong one in the sense that they form a unity. On the other demonstration proves a connection between two different subjects that cannot form such a strong unity. It follows that demonstrating definitions is an insurmountable task. In demonstrating a definition something as strong as a definition must always be assumed. And this was what demonstrating definitions was devised against.[202] This forms the basis of the tension between demonstration and definition in the early chapters of *APo.* II. The relation between the elements in a definition, between *definiens* and definiendum, cannot satisfy the demands of demonstration, i.e. the derivation of a mediated predicative relation through prior, explanatory, unmediated relations.

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[201] The second leg of the argument in 91a26-32 shows that the relation of the middle term must be just as strong as the relation between the two extremes but rather stronger: And in general if one can prove what man is, let C be man, and A what man is... If then it [AaC] is deduced it is necessary for A to be predicated of every B, and there will be an intermediate account [B] other than this [A] so that this too will be what man is so you assume what you have to prove; for B is what man is.' So there is an asymmetrical relation, similar to the asymmetry between *explanans* and *explanandum* as exemplified in cases such as the following one: (1) Planets do not twinkle and (2) Planets are near.

[202] So again the problems that surface in *APo.* II.4 relate to the difference between demonstrative explanation as offering an explanatory link between two different entities, and definition as composed out of elements that form a strong, unmediated unity.

4.2 The Aporetic chapters II: APo. II 5-7, the case against division

Since demonstration is rejected as a sound method for forming definitions Aristotle turns to the problematic features of the alternative method of formulating definitions, that of division. In II.5 he sets up this second horn of the dilemma and reiterates the objections against the method of division put forward in *APr.* I.31. In *APr.* I.31 Aristotle attacks the method of division because, contrary to what the divider claims, division cannot establish scientific knowledge.[203] In particular he points to the following problematic features:

(I) Division asks for what it ought to be proving, (46a33-4)
(II) Division always deduces something higher up, (46a34)

Further, what contrasts division with demonstration is that in demonstration the middle term must be both less than the first of the extremes and not universally true of it, while division tries to do the opposite. Hence a third problematic feature of division is that,

(III) Division takes the universal as the middle term (46a39-46b1)

Let us examine these features by considering the illustration Aristotle offers: let *A* stand for animal, *B* for mortal, *C* for immortal, and *D* for man, whose definition we try to establish. The premises endorsed by the divider are:

(1) Every *A* is (*B* or *C*)
(2) Every *D* is *A*

What can be derived from (1) and (2) with respect to *D* is:

(3) Every *D* is necessarily (*B* or *C*)

However what needs to be proved is the following: (3*) D is necessarily B. (46b10-11) In order to derive (3*) the divider would need to assume a further premise, e.g.: (4) No *D* is a *C*. But assuming (4) is like assuming (3*), for given (1) and (2) (4) entails (3*) and (3*) entails (4). Hence the charge, (I) above, that the divider asks for what he needs to prove, i.e.

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[203] Division is only a weak deduction.

(3*).[204] He can only prove that the disjunctive predicate 'mortal or immortal' is true of all humans, but he derives (3*) by assuming what he needs to prove.

The second problematic feature, (II) is that division deduces something higher up. Aristotle must mean something higher up than what the divider is supposed to prove.[205] Indeed the predicate 'mortal or immortal' is higher up than the predicate 'mortal' in the sense that its extension includes the extension of the latter. What causes this anomaly is that division fails to establish that anything more specific than the predicate 'mortal or immortal' belongs to man.

Objection (III) is that division takes the most general terms as the middle term, while the middle must be both less than the first of the extremes and not universally true of it. (46a39-46b2; cf. ll. 46b20-25.) The universal which is wrongly placed as a middle term is *A*, animal. The term which is wrongly placed as the first extreme is *B or C*, i.e. mortal or immortal. If we compare the extension of *A* to that of *B or C*, *A* is not wider than *B or C*. The two terms are co-extensive.[206] So strictly speaking it need not be the case that the

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[204] One reading of the complaint is that 'using the Platonic method of division to show that human is a mortal animal, the definer assumes that humans are animals and consequently begs the question. The truth of the formula that results from the application of the method of division is not guaranteed by the procedure.' [Modrak (2001:92)] But it is not the assumption that all humans are animals that causes Aristotle's complaint. For according to l. 11 what the divider asks for is the claim that man is a mortal animal (the same point is made in the next example in 46b18-9). If so the problem is not that the divider assumes that the predicate animal belongs to all humans, even in genuine Aristotelian definitions the genus is assumed, but rather that the divider instead of proving that the predicate mortal belongs to all humans he assumes it.

[205] So Ross 'what the Platonic method of division does prove is that the subject possesses an attribute higher in the scale of extension than the attribute to be proved.' (1949:398)

[206] The same is true of the terms in the following example where *A* stands for *mortal animal* and *B* and *C* for the differentiae *having feet/not having feet*. Hence it is not the case that the term which is wrongly placed as the first extreme is both less than the universal and not universally true of it, as Aristotle claims in his criticism. (See also Mignucci (1969:469)) See also B.16 98a35 and Barnes' comments (*ad loc.*). It seems that the major and middle term could be co-extensive. Charles interprets the first premise of the criticised syllogism differently. He takes it to be 'All men are animals'. If this is the first premise, then Aristotle criticism is justified. However the text suggests that the first premise is 'All animals are mortal or immortal'. Perhaps Charles anticipates the present difficulty by taking the text differently (2000:193). One way out of the difficulty is to take Aristotle as saying that the first extreme should not have a smaller extension than the middle, i.e. that it should not extend further or be equal in extension with the middle. This would save the example. Another way out would be to claim that the extreme in our example here is indeed less and not universally true of the middle, for the extreme the divider needs to use in order to derive his claim that man is mortal is the predicate mortal which is not universally true of animal.

middle is wider than the extreme. What is important is that even where the genus and a disjunction of coordinate differentiae are co-extensive, one cannot deduce anything more specific about the subject than what it is assumed.

The aim of objection (III) is not to point to a way of restructuring the terms of the division. Even if the universal were placed as the first term and the differentia as a middle, the divider could not prove anything but (7) below:

(5) Every (*B* or *C*) is *A*
(6) Every *D* is (*B* or *C*)

(7) Therefore, every *D* is *A*

(7) is not the definitional connection the divider aims at proving, namely the claim that every *D* is *B*.[207] In order to get that the definer needs a middle term connecting *D* and *B* as the two extremes of a syllogism. The premises obtained by division cannot offer such a middle term.

Division is an inappropriate method for deducing a definition. What division leaves to be desired is a method of finding the appropriate middle terms for proving the desired conclusions. It is probably in this way that we should understand Aristotle's severe remarks: 'it is evident, then that this way of investigation is neither suitable for every inquiry nor even useful in those very cases in which it appears to be most appropriate.' (46b35-7) The cases in which division is thought to be appropriate but fails are deductions of definitions. 'Inquiry', on the other hand, ranges over refuting, arguing about things other than definitions (e.g. *propria* or genera), and offering us knowledge that we do not already possess. (46b26-37) This does not entail that all these tasks can be accomplished by deductions.[208] It only entails that division, as used by the Platonist is not sufficient for them.[209]

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[207] See also Mignucci (1969:468).

[208] It is doubtful whether demonstrations can offer new knowledge. Perhaps they can convey new knowledge 'not by showing us new facts, but by giving us explanations.' [Smith (1997:161)]

[209] According to Mignucci (1969:469) the objections put forward against division depart from the thesis exposed in chapters 27-30 that every possible problem regarding the predicative relation of two terms could be resolved by means of the method of searching for a mediate term. See also

So Aristotle's critique is neither destined to condemn the use of division in defining, nor to establish that scientific demonstration is sufficient for all other inquiries mentioned. As we saw in the *Topics* division and the inquiry on similarities and differences has a role to play in investigating, testing and constructing definitions. If Aristotle's views are not radically revises *APr.* I.31 critique is limited in its scope.

The same stance is taken in the criticisms of *APo.* II.5. The chapter opens by linking division and induction, because the certainty that can be acquired by the two methods is similarly opposed to the certainty acquired by scientific demonstrations.[210] The problematic features of division relate not to the use of division as a part of the procedure of formulating definitions. The criticisms concern the use of division for forming demonstrations of definitions. The first objection is that, (1), division either asks or grants the conclusion that one aims at proving.[211] Secondly, (2), the divider does not deduce what it is possible for him to deduce.[212] Then Aristotle mounts two further objections at 91b24-5 (the first of which is probably anticipated in 91b20 ff.). Even if the string of words the divider puts forward as a definition is true of the subject there is no guarantee that, (3), the string of words is a definition, or, (4), that all and only the definitory parts are included in it.[213] (3) and (4) express two worries. (4) relates to completeness, how can the divider secure that he

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Modrak (2000:91-2). According to Bolton the *Topics* offer a unique and monolithic conception of definition (1993:209). Bolton means that this unique method is monolithic. Yet the *Topics* do not offer a unique conception of definition. Therefore, it is doubtful that the method is monolithic as well.

[210] This is no small concession, given the pre-eminent role of induction in acquiring knowledge e.g. in *APo.* II.19. Bolton understands Aristotle as making exactly the opposite point, namely that division is unlike induction.

[211] II.5 91b15-16. See *Topics* 158a7-13. In *APr* I.31 the divider can only prove that 'man is either mortal or immortal', instead of the conclusion 'man is mortal'. In order to derive the latter he needs to assume what he tries to prove, namely that man is mortal. This is the case at each step of division. (Barnes 1994:201)

[212] What are these attributes? Both (1) and (2) stem from the fact that divider tries to prove 'man is mortal' instead of 'man is mortal or immortal'. As Barnes suggests Aristotle must be referring to disjunctive predicates formed out of the co-ordinate differentiae in a division.

[213] Barnes claims that (3) and (4) come down to the same thing, so (4) is a restatement of (3). (1994:201). By this he means that (4) specifies in what way the problem in (3) is realised. But, of course, (3) leaves open the possibility that the formula does not contain a single definitory element, i.e. that the whole tree of the division has gone astray failing to divide by essential features of the

collected all definitory elements. (3) relates to predication in the what-it-is, how can the divider secure that he collects only predicates predicated in the first figure of predication. Further, predication in the what-it-is points to a special sort of unmediated unity between subject and the elements in the predicate. So the worry here could be expressed in terms of unity. How can one secure that the definitory elements collected make up the appropriate kind of unity?

The last two paragraphs of the chapter, 91b28-92a5, take some positive steps in that direction, addressing completeness and unity. With respects to completeness four conditions are given, conditions present implicitly or explicitly in the *Topics*, and reappearing in II.13:

> Now these points are ignored; but it is possible to solve them if one [a] assumes everything in what the thing is, and [b] makes the division consecutive by [c] postulating what is primitive, and [d] leaves nothing out. [This is necessary if everything falls into the division and nothing is omitted; and this is necessary, for it must already be atomic]. (Barnes' tr. 91b28-32)

According to [a] the divider can solve the problem by assuming all the items predicated in what the thing is. This is not very informative for the question was how can the divider be certain that he has all and only the definitory elements. The only new element in [a] is the verb rendered as 'assume' (λαμβάνειν). Whatever the weight of this expression it seems that conditions [b], [c], [d] can be read as guaranteeing, or explaining how this act in [a] is possible.[214] The divider must take what is primitive [c], i.e. prior by nature. Thus he should start from the genus. He should divide consecutively [b], leaving no gaps and dividing all the way down to indivisible entities, [d]. In this way he does not omit any definitory part. If so the three conditions entail that no non-definitory part is included, and that all and only predicates in the what-it-is are included as required by [a].[215] So [b] and [c] point to one of

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species. More importantly, if we take, with Ross, l.20 as introducing (3), there is at least another aspect on failing to be the definition of a subject, namely failing to be a unity.

[214] All three point to elements of the method that will be elaborated further in II.13.

[215] This again echoes the *Topics*' insistence on the importance of the genus in definitions. The reason is that the genus is the primary item predicated in the what-it-is.

the constraints that must be satisfied for dividing the genus properly, and [d], adds the further constraint, that the division should be carried all the way down so that no definitory part will be left out of the definition.[216] Aristotle concludes that although division may not suffice for deducing the desired conclusions 'it makes us familiar <with what a thing is>, if at all, in some other fashion.'[217] This claim is backed by an analogy with induction. Induction though not demonstrative, is capable of making something clear. The same holds of division.

Let us sum up the above discussion. The negative result is that the question 'how will a definer prove a thing's essence or what it is?' (92a35) receives no satisfactory answer. It cannot be proved by demonstration, nor can it be proved by induction or division.[218] So the discussion ends in a puzzlement. However, *APo.* II.3-7 offer some constraints that a solution to the puzzle must satisfy. First the unity condition: how is it guaranteed that the string of words will form the unmediated unity required by a definition?[219] Unity demands that the relation between the essence and what it is the essence of cannot be analysed by some more

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[216] Alternatively [d] could be pointing at a stage subsequent to the division where the predicates that will go into the definition are collected. But this sounds trivial. A third option could be that in dividing a genus there are a number of different tree-divisions that need to be explored and none of them should be neglected in forming the definition. We should divide the genus in all these respects in order to arrive at definitions of the subjects from which no definitory part is left out.

[217] 91b32-3. This condition need not be read as implying that Aristotle is in real doubt here. He may leave this possibility open since he has not offered any arguments yet for such a method.

[218] 92a35-7, b4-12; 92a37-b1. In *APr.* II.23 68b13-14 these are the only two ways we come to believe something. Aristotle adds here that we cannot give ostensive definition either. (92b2-3)

[219] Division comes in play in the concluding lines *APo.* II.6. where Aristotle argues that proof by hypothetical argument and proof by division face one and the same difficulty, namely how is the *definiens* a unity. This must be a restatement of the worry expressed in II.5 91b20 and 91b24-5. How is the divider guaranteed that the string of words in the *definiens* although truly predicated of the *definiendum* (I) stand for definitory parts of it and (II) are predicated in the relevant way, i.e. as definitory parts? *APo.* II.6 is studied in parallel with *Topics* H.3. Commentators are divided on the issue of hypothetical arguments. Some believe that the two texts are incompatible (Maier, Barnes) and suggest that *APo.* II.6 was written to correct *Topics* H.3. [Barnes (1994:212)] Some (Cherniss; Ross) believe that Aristotle allows for proving definitions by a dialectical syllogism (in *Topics*) while disallowing a deductive syllogism of the definition in II.6. The first argument: a9-19. The second: a20-27.

basic causally relevant relation. Secondly, division is divorced from demonstration but it is linked with induction, and this method will prove useful in defining.[220]

The last point is implicitly confirmed by the concluding argument in *APo.* II.7 for the impossibility of definition. Since the definer cannot prove that a thing is, what he can prove is either what the thing is or what the name that stands for the thing signifies. Both options are problematic, for Aristotle had argued at length, in *APo.* II.4-7 against the possibility of proving what a thing is, and here he gives a number of arguments against the possibility that the definer proves definitions of what a name signifies. It must be noted, first, that the dilemma ignores the possibility mentioned in II.5 91b34-5, that definitions state what something is without proving it. This possibility is silenced because this is the way Aristotle is going to spell out his solution to the puzzle concerning definition and demonstration.[221]

5. The positive account I: APo. II.8-10

From *APo.* II.8 onwards Aristotle spells out his own account concerning definition. *APo.* II.8-10 offer part of the positive account, while *APo.* II.13-14 offer a complementary or (exclusive) alternative solution. II.8 establishes that demonstration and definition are after all compatible in one sense, and for at least one kind of *definienda.* II.9 introduces briefly a crucial distinction between self-explanatory and non-self-explanatory *definienda.* Finally II.10 summarises different kinds of definitions. The three chapters constitute evidence against the first horn of the dilemma put forward in the aporetic chapters, namely that

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[220] Bolton (1993:206) notes that chapter 5 makes some positive point. It is not only demonstration that offers scientific knowledge. Therefore we cannot argue from the fact that a method is not demonstrative to the conclusion that the it does not furnish scientific knowledge. And this holds also of induction. Bolton takes it that induction here is contrasted with division. But this is not at all evident. To the contrary, induction is linked with division. For it offers an example of a non-demonstrative method which plays a part in our getting scientific knowledge. And Aristotle's point is that the same is true of division. Bolton must be right in the further claim (207), that the characteristics obtained by division are not fundamental they can be explained by a why answer.

[221] Whatever the referents of the bearers of definitions here the argument aims at showing that neither their existence nor their definition can be proved. The possibility is still open that what cannot be proved might be stated in some other way. Later on it is the existence and definition of primitive subjects that cannot be proved but assumed. See Barnes. (1994:206)

definitions cannot be arrived at through demonstration. The second horn, namely that definitions cannot be arrived at through division, is argued against in II.13-14. There is no agreement on the solution proposed in II.8-10, and its relation with the remarks in II.13. It is impossible to address all the interpretative difficulties surrounding this discussion. I will try to highlight some elements that allow for a consistent reading of the solutions offered in II.8-10 and II.13, and argue that the pre-eminence of the genus and the rules of division and of causal explanation are integral parts of Aristotle's solution here. If so there is no reason to observe here a radical departure from certain views expressed in the *Topics*. The *Analytics*' account and the practice followed in biology complement and refine these convictions offering a more robust account of essential properties.

The discussion opens with a restatement of the identity between what something is and the explanation of why it is the kind of thing that it is (II.8 93a4-5, cf. II.2 90a14-23, a31-34):

> As we said, to know what something is and to know the explanation of whether it is are the same; and the account of the fact that something is is the explanation. This is either [a] the same as it or [b] something else; and if it is something else it is either [b1] demonstrable or [b2] indemonstrable. If it is something else and it is possible to demonstrate it, then the explanation must be a middle term and the proof must be in the first figure; for what is being proved is both universal and positive (93a4-9)

Here explanations are divided into (a) explanations identical to, and (b) explanations different from, the things they explain. Aristotle gives no examples for his distinction between self-explanatory and non-self-explanatory items.[222] Ross envisages that Aristotle draws a distinction between substances and non-substances.[223] Barnes, following Scholz,

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[222] Neither here nor in II.9, where he deals with self-explanatory items. Does Aristotle refer here to two distinct sorts of entities distinguished by the different way they are related to their causes? Philoponus influential interpretation is that Aristotle distinguishes here two ways of expressing the cause of one and the same thing. (364) Similarly Bolton 1987 130-142. For a detailed discussion and rejection of Philoponus' suggestion see Goldin. (1996:102-106)

[223] Thus Ross writes: 'A substance is the cause of its own being, and there is no room for demonstration here; you just apprehend its nature directly or fail to do so.' (1949:629) Actions and events constitute the class of non-self-explanatory items. Similarly LeBlond, cf. Deslauriers (1990:7).

argues that the distinction is between the denotata of primitive terms of a science that are indemonstrable and the denotata of the corresponding derivative terms that are demonstrable.[224] II.9 indicates two points that may give an initial grasp of the self-explanatory/ non-self-explanatory divide:

> Of some things there is something else which is their explanation of others there is not. Hence it is plain that in some cases what something is is immediate and a principle; and here you must suppose, or make clear in some other way, both that the thing is and what it is. (Arithmeticians do this: they suppose both what a unit is and that there are units). But in cases where there is a middle term and something else is explanatory of the essence you can –as we have said- show what something is through demonstration without demonstrating what it is. (93b22-28; Barnes' tr.)

According to Barnes 'Aristotle here argues from the fact that some propositions are immediate and self-explanatory to the conclusion that some essences are immediate and hence principles.' (1994:221) But, surely, if the essence of *A* is immediate iff there is no middle connecting the terms in the proposition stating the essence of *A*, every essence is immediate. This indicates that immediate essence might mean something different here. Barnes takes it as unanalysable, where unanalysability is unique to primitive terms: 'they have no parts which can be exhibited in the terms of a demonstration and they must be made familiar in some way other than that described in II.8.'[225] But immediacy may point to another feature here. The non-immediate connections explored in II.8 include the predicative relation between a substance, e.g. moon, and an affection or position, loss of light by the interposition of the earth, and the predicative relation between a quasi-substantial subject, e.g. clouds, and a quality or action, extinction of fire. So eclipses and thunders depend on some inter-categorical predicative relation, i.e. to a kind of predication other than

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[224] A third alternative is that Aristotle is talking about some kind of primitive subjects not quite in the sense that Barnes takes them. So Deslauriers (1990:2), and Goldin who labels them epistemic substances. (1996:109-110). See also McKirahan (1992:199-201).

[225] Further it is not clear what is meant by 'supposition'. According to Barnes there are two problems with supposition. First all definitions are supposed or posited. Secondly, supposition is not a way of making familiar. But Aristotle does not seem to put much weight on supposition here which he leaves relatively open: 'and here you must suppose, or make clear in some other way, both that the thing is and what it is'. See also *Met* E.1 1025b11.

the first.[226] If so then the contrast between primitive and non-primitive terms may be that the immediacy of the former is due to the fact that the predicative relation in their definitions are first figure predications.

This suggestion explains the curious phrasing of the concluding remark of the passage: 'in cases where there is a middle term and something else is explanatory of the essence you can show what something is through demonstration without demonstrating what-it-is.' Here Aristotle is not simply saying that the explanatory cause, being the essence of the thing in question, is different from that thing. He makes the further point that a demonstration in this case does not demonstrate what something is, its *ousia*.[227] Aristotle may mean here that the explanatory cause cannot demonstrate the *ousia* of that thing because it is different from it. If the contrast between primitive and non-primitive terms rests on unanalysability, as Barnes suggests, the remark is obscure. Even if the explanatory grounds that explain, say biological kinds, are different from what they explain, it is certainly not the case that they are different from their *ousia*. So Aristotle must have in mind a different contrast. The distinction between inter-categorical and intra-categorical predication can capture this contrast. Eclipses are cases of loss of light, i.e. affections, but their causes relate to the rotation of the planets, i.e. to movement of substances. Thunders are noises, i.e. qualities, but their cause, quenching of fire, is a different kind of ontological item, an action.

The second thing to note in the above passage is that non-self-explanatory items are distinguished from self-explanatory ones by means of the methods that can be used for formulating their definitions. In the former case demonstration is useful. In the latter case

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[226] Eclipse and thunder are more similar to complexes such as 'white man' (rather than 'man' or 'white'). The same must hold for their definitions. In that respect the definition of 'white' is more like the definition of 'man' than that of 'eclipse' or 'thunder'.

[227] The contrast may be between showing the connection through demonstration and demonstrating the connection in the sense that it appears as the conclusion of the demonstration. But this is not the only way that the two cases can be contrasted.

there is some other way. The remark is obscure yet it suggests that II.8 makes the case only for non-self-explanatory subjects. So let us look at II.8.

In II.8 non-self-explanatory items, (b) above, might be things that, (b1), can be used in demonstrations,[228] or not ((b2) above). If (b1) is the case then the explanation must be a middle term in a first figure syllogism. The text seems to implicitly deny that there is demonstration in the case of self-explanatory items, (a). This accords with *APo.* II.9 and the argument of II.3-4, where Aristotle exploits the tension between the unity constraint for definitions and the middle term constraint for demonstrations.[229]

Furthermore, what is demonstrated in the case of things under (b1) suggests the impossibility for demonstration in the case of items in (a) in the following way. The explanation of how demonstration can be used points to the following features. First, grasping the fact and grasping the reason why the fact is the case may either succeed each other in time, in this order, or may be grasped at the same time. They can never be known in the opposite order. The relation between grasping whether a subject exists and what it is, is similar. They can either be known in this order or at least simultaneously.[230] What is impossible is to know the explanation before the fact or the *definiens* before knowing that the *definiendum* exists. The second point is that Aristotle strengthens this claim by saying that whether something is can either (a) be grasped in some weak sense, i.e. incidentally, or (b) by having something of the object itself. The reference of the term συμβεβηκός in (a) is not clear. But the claim is that this way of being aware that the thing exists cannot give us any knowledge of definitory elements or even knowledge that the thing exists. (93a24-6) And if

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[228] This is how we should understand, with Barnes, *demonstrable.*

[229] The discussion of II.3-4 is in the background. In 93a9 Aristotle rejects again the syllogism of II.4 91a14 ff. where the definer proves one definition by means of another as a middle term. Ross thinks that the objection here is that in dialectical syllogisms we have a *petitio principi.* For the opposite view see Barnes' commentary (*ad loc.*).

[230] See also 89b29-34; 90a16-8. Ross says (1949:630): 'In fact when we are dealing not with a substance but with a property or event, whose *esse* is *inesse in subjecto*, to discover its existence is the

we do not know that the thing exists we cannot ask the 'what is it?' question. If, on the other hand we grasp something of the thing itself, and not a συμβεβηκός of that thing, we thereby grasp the fact that it exists. Then we are able to discover what the thing is.[231] The third point consists in the introduction of demonstration. When we grasp something of what the thing is, at the same time as grasping that it is, we possess the terms that can be put in a demonstrative syllogism. For we grasp that eclipse, *A*, of the moon, *C*, is a screening by the earth, *B*. (93a29-31)

Now let us turn to συμβεβηκός. The term is used in a variety of ways in the *corpus*[232] and its interpretation here is the object of controversy. Partly because the interpretation of the attributes that fall under its scope will determine what attributes can and what cannot give us knowledge that the thing exists, i.e. the interpretation will establish the epistemological demands made by Aristotle. The strongest position, as suggested by Zabarella, is to take Aristotle as demanding knowledge of a thing's full definition. Only then it is possible to devise an understanding of the entity in question. Goldin, on the other extreme, suggests the weakest position according to which knowledge of mere necessary predicates can lead to knowledge of the what-it-is of that thing.[233] The middle position, endorsed by Ross and Barnes, is to take συμβεβηκός as excluding only essential or definitory predicates. Hence what the passage demands is grasping of some essential predicate. The following reasons enforce this line. First, συμβεβηκός here is contrasted with the definitory elements of a subject, and this suggests that it covers non-essential

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same thing as discovering the fact that it belongs or happens to some subject, and to discover its essence is the same thing as to discover why it belongs to that subject.'

[231] But what about the case where we get the that it is before the what it is? Ross asks: how we could infer the existence of something, man, from that of something else, animal, without having some knowledge of the nature of that whose existence we infer? (1949:630-1). An example where one grasps the that without the what is given below in 93a36 ff.

[232] Apart from the uses presented in the *Metaphysics* V.30 on συμβεβηκός (1025a14-30) the term is used in a variety of ways in the *Topics* and the *Analytics*. In the former it is synonymous to accidental attributes (see *Topics* I.5 & 8). In *APo.* I.2 Aristotle refers to necessary attributes of a

characteristics in general, either necessary or accidental attributes. Further, the examples are cases where one grasps the genus and some differentia of the subject, i.e. definitory elements.[234] Finally, grasping the subject incidentally entails a state of awareness, which is somewhere in between knowledge and ignorance. So the passage points to the following four epistemic stages of a subject, *x*, with respect to the definition and hence the nature of a kind, *K*:[235]

(a) *x* is ignorant of whether *K* exists,
(b) *x* knows that *K* exists because *x* knows some incidental property of *K*,
(c) *x* knows that *K* exists because *x* knows some non-incidental property of *K*,
(d) *x* knows that *K* exists because *x* knows the full definition of *K*,

(b), a middle point between ignorance and knowledge,cannot rely on knowledge of mere accidental properties. For how can one get from accidental features, i.e. features that may or may not belong to the self-same subject at different times or respects, to non-accidental ones? Thus it is more plausible that the reference of συμβεβηκός includes necessary non-essential predicates.

Two reasons have been proposed against this reading. First why would Aristotle hold that knowledge of necessary properties does not facilitate the inquiry into essence? Secondly, Aristotle offers just such an example where knowledge starts from a non-essential necessary predicate in the following passage:[236]

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subject by the expression *kath hauta sumbebekota*. Finally in at least one passage from *PA* I 645b1-3 the word refers to essential properties.

[233] See Goldin (1996:115-7); Charles (2000:35).

[234] The examples are: (I) thunder is a sort of noise in the clouds, (II) eclipse is a sort of loss of light, (III) man is a sort of animal, and (IV) soul is a thing that moves itself. According to Ross the examples point to the genus or some other element in the essence. (1949:630) Barnes agrees after considering and rejecting (I) the possibility that we grasp the nominal definition (ND) for (a) the examples are not ND's and (b) ND's imply incidental knowledge (II.10 93b32-5), and (II) the possibility that we grasp non-essential characteristics. Barnes argues that it may be the matter or the genus, therefore we should interpret the passage not specifically. In that case Aristotle by συμβεβηκότα cannot merely mean accidental features but e must include necessary properties such as the *Topics' propria*. (See also Demoss & Devereux (1988:145); Charles (1990:151)).

[235] A different interpretation is proposed by Charles. (2000:35).

[236] According to the previous passage we do not have knowledge of the fact that something is, unless this comes together with an initial grasp of the 'what it is'. Anything less does not suffice to

When we discover it we know at the same time the fact and the reason why, if it is through immediates.[237] Otherwise we know the fact but not the reason why: moon C, eclipse, A, not being able to produce a shadow during full moon although nothing visible is between us and it B. If B, not being able to produce a shadow although nothing visible is between us and it, hold of C, and A, being eclipsed, hold of B, then it is plain that it is eclipsed but not yet why; and we know that there is an eclipse but we do not know what it is. (93a36-93b2, Barnes' tr.)

The key to an answer to the second objection must lie in the conditional that qualifies the passage. The discussion is explicitly limited to cases where we know that something is through non-immediate connections. These cases are contrasted with the immediate relation between interposition by the earth and eclipse. The non-immediate connections must be related to the συμβεβηκότα of ll. 20-24, i.e. they are necessary predicates. How are we to reconcile then the fact that these non-immediate connections give knowledge of the 'that' while the same non-immediate connections do not guarantee such a knowledge in ll.20-24? First, ll. 20-24 leave open the possibility that knowledge of the 'that' may precede knowledge of the 'what'. This allows for the kind of example given in 93a29-b1. Knowing the 'that' before the 'what', entails knowing something about a subject which is not essential or immediate to that subject. This is what the illustration of 93a29-b1 is an illustration of. Then, how are we to understand the claim in 93a27 that unless we know the 'what' we do not have grasp of the 'that'? A plausible suggestion is that the verb is used first in a weaker then in a stronger sense. In the weak sense it is possible to know that something exists by possessing knowledge of a non-definitory attribute. Starting form such an attribute it is possible to find out what something is. So in the weak sense knowing incidentally can help. In the strong sense we do not even know properly that the subject exists for non-definitory attributes give us no knowledge of what the subject is, but only of secondary qualities. We do not even know what kind of subject it is, nor under which category it falls. So in the

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establish that it exists. By contrast in the following passage we are given an example where without grasping something of what the subject is one is able to grasp that the thing exists.

[237] I read, with OCT and Ross δι ἀμέσων instead of the MSS's δια μέσων.

strong sense knowing incidentally is not sufficient to establish knowledge that the subject exists.[238]

This suggests the following defect of grasping the existence of a subject through non-definitory predicates attributes, either accidental or necessary non-immediate ones. The predication relation grasped leaves relatively indeterminate the kind of the subject. It is not grasped as the kind of subject that it is. By contrast, determining a subject through the genus sets limits both (a) for the sort of cause we are searching, for what is to count as an *explanans*, and (b) for the kind of *explananda* that need to be addressed. Moreover, the definer is not giving definitions of isolated subjects. He works inside the limits of a subject-genus and and his work is comparative. Non-essential characteristics cannot help detecting, classifying and focusing on the cases that fall under this genus, and thus advance the inquiry into the natures of the subjects of the genus.

This consideration can meet the first objection, i.e. why knowledge of necessary predicates does not facilitate the inquiry into essence. The distinction of a weaker and a stronger sense of 'knowing', allows that in the weak sense even non-essential predicates can be useful in advancing our knowledge on the nature of things. However, in the strong sense it is knowledge of essential properties that is needed.[239]

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[238] Lines 93a24-29 may be taken as suggesting exactly this depending on how the phrase that the business of knowing that something exists is and of knowing the definition is easier when we grasp something in the what of the subject. This qualification suggests that there is also a less easy way of knowing these things, namely the one that is covered by the weak use suggested above. If such a distinction makes better sense of the text, it is interesting that Aristotle does not offer any example of primitive subjects known in the weak sense. Perhaps in their case no weak sense, i.e. incidental knowledge, is operative.

[239] For instance, biological subjects must be picked out as cases of living things, i.e. through their genus. For without it one is in no position to know whether he should look for teleological explanations or non-teleological explanations as the ones that apply to natural phenomena such as eclipse and thunder. He needs to know the sort of *explanantia* he is looking for. Secondly, grasping the genus is necessary for grasping that in cases of living things what is relevant are parts of organisms through which one can derive soul-faculties. A comparative study of these parts divides living things into groups. If one begins from necessary features of the kind he will not be able to get to the nature that explains the soul functions of these groups of animals. So he needs to know the genus in order to locate the right sort of *explananda*.

So II.8-9 introduces a distinction between primitive and non-primitive subjects and insists on the importance of grasping something of the *what*, especially the genus, in order to be aware of the *that*. This grasping in the case of primitive subjects may involve supposition or something other than demonstration. The relation of demonstration to definition is clarified for the case of non-primitive subjects. This does not entail that similar demonstrations cannot be formulated in the case of primitive subjects. However, there are things other than demonstration playing an important role in their case.

This suggestion is in accordance with the classification of definitions in *APo.* II.10. Four types are distinguished and on one reading of II.10 definitions for self-explanatory and non-self-explanatory are classified under types (2) and (4) below:[240]

(1) an account of what a name signifies (nominal definition) 93b29-37,
(2) an account which shows why something is, similar to a demonstration of what something is but differing in arrangement from it, 93b29-94a7,
(3) the conclusion of such a demonstration, 94a7-9
(4) an indemonstrable definition of what something is, 94a9-10.

There is a discrepancy with the conclusion of II.10 summarising only three types. The traditional interpretation is that all four types are genuine, but nominal definition are scientifically uninteresting and hence omitted in the summary.[241] By contrast, Ross takes it that there are only three types: (1) does not deal with such a thing as the uninteresting case of nominal definitions, but with the type of definition dealt with in (3).[242] At any rate, what interest us here is whether type (2) and (4) refer to different kinds of *definienda*, i.e. to self-explanatory and non-self-explanatory subjects. According to Deslauriers (2) and (4) answer correspondingly (a) the 'why it is?' and (b) the 'what it is?' questions outlined in *APo.* II.1 89b24-25. (1990:4) Although this is controversial given that Aristotle identifies the two

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[240] Although the sets of definitions satisfying (2) and (4) are different, they may overlap.

[241] See *APo.* II.10 94a11-4. Barnes follows the traditional interpretation, but ultimately argues that only one type is genuine, namely (2). Definitions under (3) are partial definitions and thus parts of definitions under (2), while (4) is the product of confusion. (1994:223-4)

[242] Similarly Bolton (1976) identifies types (1) and (3). But contrary to Ross he takes them as dealing with nominal definitions.

questions in II.2 90a14-5, the two questions may not come to the same thing in all cases. Even if every 'what is it?' question is a 'why is it?' question the identification may not have the same force for every kind of subject.[243] For subjects whose cause is a further entity the unified question must refer to this entity. For self-explanatory subjects the unified question has a different force, for the answer does not invoke the existence of a different entity.

Moreover, the why-is-it/what-is-it distinction is connected with the distinction between the whether-it-is/that-it-is questions. The whether-it-is, as Deslauriers notes, asks for a predicative relation in figures of predication other than the first. It typically asks for inter-categorical predicative relations, exemplified by the case of thunder which in II.10 illustrates definitions of type (2). The that-it-is question relates to items whose explanation is not different from themselves.[244] The examples here include basic subjects such as moon, night etc. On the basis of these observations Deslauriers suggests the identification of answers to the 'why is it?' question with type (2) definitions of non-self-explanatory items and answers to the 'what is it?' questions with type (4) definitions of self-explanatory subjects.[245]

If type (4) definitions point to a special type of *definientia*, self-explanatory items, which differ from non-self-explanatory subjects dealt with in II.8, one expects a further elaboration of the theory of definition so as to cover the former case. After all in II.9 it was claimed that in the case of definitions of self-explanatory subjects 'you must suppose, or make clear in some other way, both that the thing exists and what it is.' (93b23-24) Such a

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[243] Deslauriers argues for the stronger claim that the corresponding objects of the 'what is it?' and 'why is it?' questions are always different. (1990:4) She draws support from *Met.* VII.17 1041a10-15.

[244] Deslauriers (1990:5). Aristotle uses the expressions επὶ μέρους and ἁπλως.

[245] Deslauriers sets out the distinction between self-explanatory and non-self-explanatory subjects thus: 'The self-explanatory/ non-self explanatory distinction as I have described it is not incompatible with a primitive/derivative distinction in terms... It is incompatible with a view of primitive terms as indefinable or unanalysable, rather than simply indemonstrable (where a demonstrable term is one the connection of which to another term can be demonstrated).' (1990:14)

further examination is expected, and it is plausible to read the remarks in *APo.* II.13 as dealing with this task, i.e. definitions of self-explanatory or basic subjects of a genus.[246]

6. Conclusion

APo. II.8-10 offers a model of definition through scientific syllogism that satisfies two conditions. The explanation refers to the cause of the *explanandum* and this is identified with what is prior. Second, the *explanans* explains further predicates, necessary but non-immediate ones, i.e. non-essential, of the phenomenon. The account put forward offers some indications for distinguishing between essential and merely necessary features of the phenomenon explained. The division is based on considerations relating to explanation. On the one hand, although one could form a syllogism connecting the subject with one of its necessary features through another necessary feature as the middle term, there is no guarantee that such a syllogism would offer a scientific demonstration revealing the essence of the subject. For a scientific demonstration must proceed through the reason why as a middle term, while not every necessary feature is capable of playing that role. Necessary facts are insensitive to the needs of scientific demonstration, because they are insensitive to facts about or the direction of explanation. A scientific demonstration must account for the explanatory and ontological order of the subject genus by giving the ultimate cause of a phenomenon, such that it will explain, and hence make clear, the necessary features of the phenomenon itself. These conditions offer indications on how one can extract the essence of a phenomenon from its necessary features. Yet they do not offer safe grounds for it. The test does not offer sufficient guidance in the labyrinth of the necessary features of the primary subjects of a science. An account is needed of how definition can be formed in their

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[246] This does not entail that demonstration does not play a role with respect to the essence of this latter kind of subjects. For instance, the positing of the essence of a subject may be vindicated by using it as a middle term for demonstrating other necessary properties of a subject. However, there is no mediating term that can be used as a middle in demonstrating why the subject possesses it.

case. For what is relatively simple in the case of phenomena such as eclipse or thunder is bound to be far more complicated in the case of other subjects, e.g. biological subjects.

APo. II.9 suggests that the specific details of the II.8 account cover only one case of phenomena in need of definition, cases where the cause is something different from what it explains. In the cases of self-explanatory entities the definer must make a supposition or in any case something other than demonstration. This method need not be incompatible with demonstration, but it will involve further subtleties. Since the case of things where the explanation is not something different from the thing explained seem to be treated in II.13 the investigation of these subtleties relates to the question concerning the compatibility between the account of definition given in II.8-10 and II.13.

1. The positive account II: APo. II.13

APo. II.13 can be read as directed to disarm the second horn of the dilemma put forward in the aporetic chapters of book II. It contains a number of injunctions, some of which point to the usefulness of division in formulating definitions. Further, they offer information about the definitions of the class of primary subjects for which so far Aristotle has offered only brief remarks. The commentators are divided on the relation between the II.8-10 and the II.13 account concerning definition. One point of disagreement is whether the *definienda* in the two sections are the same. A second one is whether the definitions arrived at by the two methods are of the same kind.[247] Thus the interpretations of II.13 can be classified in the following way:

Relation between the account in II.8-10 & II.13	They deal with incompatible definitions	They deal with compatible (aspects of) definitions
The same definienda	Bolton	Charles, Barnes
Different definienda	Leblond	Ross

I will follow, roughly, Ross, in arguing that the accounts point (a) to compatible or complementary features of definition, and (b) focus on different sets of subjects (namely self-explanatory and non self-explanatory subjects). I will not follow, however, his interpretation on what items exactly are classified under these two kinds.

The distinction between self-explanatory and non-self-explanatory subjects is put forward at II.9 93a4-9 and at 93b21-5. The essences of things falling under the latter

[247] Some argue that the two accounts point to two independent ways of defining things one of which is independent from the II.8-10 (Bolton, LeBlond). Ross, by contrast, takes it that II.13 gives practical advice as to how definitions are to be arrived at. He also argues that here Aristotle is focusing on definitions of the primary subjects of a science (by contrast to the earlier passages dealing with definition and demonstration which focus on events, i.e. on things whose cause is different from them).

category are cases of essences that are immediate[248] and first principles.[249] In those cases 'you must suppose, or make clear in some other way, both that the thing exists and what it is.' (93b23-24) What exactly this method is is not clear. If however, essences of self-explanatory entities constitute the focus of II.13, the method hinted to at II.9 93b23-4 must include division.[250] According to this suggestion II.13 deals with self-explanatory entities whose essence as an explanatory factor is not other than themselves, while II.8 deals mainly with definitions of non-self-explanatory subjects. The former class need not include only substances. It might include primary subjects under any category of being depending on what the subject-genus of the study is.[251] Further, this does not imply that the two methods are incompatible and that only definitions of non-primitive terms can be cast out in demonstrations. Demonstrations may be equally useful for clarifying the definitions of self-explanatory entities. However, some qualification, epistemological, metaphysical or both, must be added for the cases where *explanans* and *explanandum* are one and the same.[252]

Before considering II.13 in detail, let us consider an initial objection by Barnes who argues that there is no support in the text for Ross's claim that what II.8 did for causal

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[248] According to Charles these immediate principles are not to be confused with the immediate propositions of II.8. (2000:202) The opposite view is expressed by Bolton (1987). See also McKirahan (1992: 200-1).

[249] II.9 93b22. According to Ross, self-explanatory entities include primarily substances 'the cause of whose being lies in their form', but also include 'certain entities which are not substances but exist only as attributes of subjects, viz. those which a particular science considers as if they had independent existence and treats as its own subjects, as e.g. the unit in mathematics (93b25, 79a7-10).

[250] So Ross (1949:633).

[251] For instance, in the case of mathematics which deals with subjects that fall under the category of quantity, the subjects will be typically non-substantial items. According to Ross 'the existence of substances is discovered by perception; that of the quasi-substances...[such as the unit] from the data of perception' (1949:633). See also *EN* 1098b3 ff..

[252] This way of reading II.13 is not necessarily in contrast with Barnes claim that the difference between II.8 and II.13 is that while in the former 'the main question was to what extent, if at all, essences can be exhibited in demonstrations; here [Aristotle] asks how we can get hold of such potential exhibits in the first place.' Barnes (1994:240) There is tension only on the assumption that the two kinds of methodological remarks focus on the same kinds of *definienda* as their primary cases. And this is not obvious. Nor is this line necessarily incompatible with the view taken by Charles, namely that II.13 adds some metaphysical constraints beyond those specified in B.8-10. (2000:223) In Charles reading II.13 attempts and succeeds in building further metaphysical constraints for distinguishing the essential features or definitory parts of a subject. Barnes and Charles suggestions imply a further division between two possible readings. The first confines the value of II.13 on

definition, II.13 does for 'immediate' essences.[253] Barnes, for instance, argues that the example of man, mentioned at II.8 93a24, is the sort of thing that occupies Aristotle in II.13. Hence the two accounts do not treat alternative kinds of subjects. Yet this objection is not conclusive. First, typical examples of events that are pre-eminent in II.8, e.g. eclipse and thunder are absent from II.13, and this may suggest that the scope of the two discussions is different. Secondly, the example of 'man' in II.8 is cited together with further examples. Then the model of constructing a demonstration is applied to only two of these examples, but not to 'man'. And this indicates that this case is very different or more complicated, and at any rate a case where the same model does not apply in exactly the same manner.[254] Given these two observations the above objection looses its force. So let us look at the II.13 method itself.

I will concentrate on three sections of II.13. The opening lines, 96a24b14, dealing with the question why are the elements in the definition of a subject, the essence of that subject by necessity. Secondly, with the injunctions laid out at 96b15-25, concerning the way the study of a genus must process. Finally I will consider the points concerning divisions in the concluding lines of the chapter at 97a23-b6.[255]

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epistemological issues concerning definitions. The second reads II.13 as offering metaphysical constraints for the theory of definition.

[253] See Barnes (1994:240). But he must be right in rejecting the view that II.13 deals with the definition of substances, since the examples put forward in II.13 are not confined to substances.

[254] Furthermore, the example of 'man' is put forward in II.8 in order to illustrate a slightly different point, namely that when we grasp that something exists accidentally we are in a hopeless position with regard to finding out what that thing is.

[255] II.13-4 can be divided thus: II.13 Introduction: a20-23, Section I: 96a24-b14 why are the elements in the definition the essence of that thing by necessity; Section II: 96b15-25 Injunctions concerning the study of a genus; Section III: 96b26-97a23 Injunctions concerning division (with 97a7-20); Section IV: 97a23-b6 Summary of the injunctions concerning divisions; Section V: 97b7-25 More injunctions about division and the study of differences and similarities; Section VI: 97b26-39 Some more general remarks about definition; II.14: The introduction of problems as related to division.

2. Hunting for predicates in the what-it-is (Section 1: 96a24-b14)

APo. II.13 introduces the question how should one hunt[256] for the attributes truly predicated in the what it is of a subject and therefore formulate the definition of what the subject in question is.[257] This is II.13's explicit task.[258] The first section, 96a20-b14, sets a number of criteria, the first of which is spelled out thus:

(1) the predicates hunted for must hold of the *definiendum, always* (96a24).[259]
(1a) some predicates will extend further than the subject but no further than the genus,
(1b) while some will extend further than the genus. (96a31)[260]

Two points need to be pressed here. First there is one obvious class of predicates missing, namely predicates that do not extend further than the subject. This class includes co-extensive necessary predicates of a subject, predicates that counter-predicate with it. Why are they omitted? Secondly, is the definer supposed to be able to divide predicates between (1a) and (1b)? If yes, then he needs to know in advance whether a predicate extends beyond the genus or not, and by implication the extension of the genus.[261] The preceding chapters

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[256] Hunting (*thereuein*) is used in a similar way at *APr.* I.30 46a10-12, *APo.* I.31 88a3 ff.

[257] There is controversy about the phrase 'how the essence is distributed among the *horoi* (96a20). Ross and Barnes render *horos* as 'term', while Charles renders it 'definition.' (2000:222) Aristotle says that the earlier chapters dealt with the question how what something is can be elucidated in the terms of a deduction, and in what way there are and are not demonstrations and definitions of what something is. The reference must be to *APo.* II. 8-9. So Ross: 'in the demonstration which enables us to reach a complete causal definition of an attribute, the subject which owns the attribute appears as a minor term; the moon suffers an eclipse because it suffers the interposition of the earth.' (1949:656)

[258] This way of putting the question reminds one of the *Topics*. According to Themistius (88, 1) it is definitions that one hunts for. Similarly, Philoponus (398 15-7) notes that the expression what-it-is is a gloss for definitions. The *how* may indicate no more than a method, it may be pointing to an epistemological answer, or, in addition, to a metaphysical one. It may be revealing some metaphysical constraints determining what kind of thing is to be hunted. In the latter case the answer of the question would offer some metaphysical constraints of what definitions or elements thereof are.

[259] Aristotle has shown that the predicates through which we define must belong always or for the most part to their subject. For predicates that sometimes belong while some other times do not we cannot have scientific knowledge of the kind provided by definitions.

[260] A predicate, P, extends further than a subject, s_1 , to which it always belongs iff P, belongs always to a different subject s_2 in the same manner. For instance, the predicate 'two-footed' extends beyond its subject 'man', in the sense that it always belong to some other subject, e.g. 'bird', and not in the sense that there is a coincidental relation between this predicate and a two legged horse.

[261] The level of generality of 'genus' here is uncertain. It is usually taken at the level of generality of genera such as the genus number or the genus animal. But it may refer to something more general. At 96a24-5 there is one example where a predicate outside the genus, sc. existence, is inappropriately predicated of a subject, the triple. This may suggest that genus is taken in the most general way, i.e. it is fixed at the level of the great genera.

do not offer any method for carrying out such a task. What justifies the implicit assumption, in the first criterion that the definer collects intra-generic predicates of the subjects studied? This assumption echoes the constraint of the *Topics*' study of differences and similarities as a method for formulating definitions. There the genus is presupposed by this study as what is mostly predicated in the what-it-is. So it may be that what justifies the desired restriction in this first criterion is equivalent to what guarantees positing the right genus in the *Topics*.

The second criterion operates within the intra-generic predications collected by the first criterion: 'this type of predicates should be taken up to the point at which we have first taken so many that, while each extends further, all of them together do not extend further.' (96a32) Then 'this must be the essence of the thing'.[262] So this criterion can be rendered thus:

(2) The essence is necessarily composed out of those predicates under (1a) whose combination does not extend further than the subject.

Then Aristotle argues for two claims. First, (a), that the above predicates belong of necessity to the subject. Secondly, (b), that the above predicates constitute the essence of that subject. Following Ross, the steps of the argument for (a) in 96b2-5, can be laid thus:

(1) it was proved (a) that predicates predicated in the 'what' are universal, and (b) that universal predicates are necessary (73a34-7, b25-8).
(2) The predicates ascribed to the subject, here number three, are predicated in the 'what' of that subject,
(3) (from 1 and 2) Therefore these predicates are necessary to number three.[263]

The above argument proves that the proposed predicates, predicated in the what-it-is of the subject, are necessary because they are universally true of it. Universality, however, is not peculiar to predicates in the first figure of predication. Predicates in other figures may be universal and hence necessary to their subjects. But Aristotle claims something stronger

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[262] Cf. Charles' rendering: 'this is necessarily the essence of the thing'. So also McKirahan (1992:112).

[263] In line b2 Barnes reads, following the MSS and contrary to Ross, *hoti anankaia men*. Thus he translates (a) and (b) as follows '(a*) whatever is predicated in what something is is necessary (and (b*) what is universal is necessary).' Nothing said here hangs on this.

than just that the predicates are necessary. He claims that they are essential to the subject.[264] Still the argument establishes only the necessary connection between subject and predicates. The assumption that the predicates are predicated in the 'what' of the subject is transferred from the premises to the conclusion. So, as with the first criterion, the required restriction is somehow assumed, by the first argument in support of the second criterion.[265] Again one way to justify this assumption is by alluding to the *Topics*' remarks on the distinction between predication in the first figure and predications in other figures.

Let us turn to the argument for the claim, (b), that the set of predicates hunted, or the account composed out of them, is the essence of the subject. The argument is a *reductio ad absurdum* of the claim that the proposed account does not signify the essence of the triple:

(1) (assumption) This [collection of predicates], d_1, is not the essence of the triple.
(2) (assumption) If this is not the essence of the triple, it must be some sort of genus (either named or nameless) (96b6-8).
(3) A genus is the sort of predicate which potentially extends further [than any one of the subjects included in it] (96b8-10)
(4) (from (1) (2) & (3)) d_1 must extend further than the triple (96b8),
(5) It was shown that d_1 belongs to nothing else than the individual threes (96b10-11),
(6) (assumption) The essence of each thing is the final such predicate that belongs to all the individuals (96b11-13).

The conjunction of (5) & (6) contradicts (4).[266] If (4) is false, then at least one of the premises supporting it must be rejected, and the best candidate is (1).[267] Hence,

(7) This [collection of predicates] is the essence of triplet. (96b11)

What is the force of (5) and (6) and what justifies them? (5) depends on observation. The collection of predicates that makes up d_1 applies to nothing but individuals falling under the kind 'triple'. Establishing (5) requires, first, a list of subjects. One cannot establish (5)

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[264] In 96b5 he concludes that these predicates are of necessity the triple, i.e. they are of necessity the essence of the triple, they collectively constitute the essence of the subject.

[265] So the predicates excluded by the assumption constitute a wider class from predicates that belong by necessity and extend no further than the subject, which we classified as (2a) above, and which were omitted in Aristotle's categorisation of predicates here.

[266] Given that (6) is a general principle, (4) must be false for every subject, s, and for any predicate, p, whenever (5) is true of them.

without considering other subjects to which d_1 does not belong. Further, these subjects must fall under a common genus.[268] So establishing (5) requires information about subjects that are correlative with the *definiendum*, and knowledge of their common genus.

For (6), on the other hand, there is no justification in our section. But it may be justifiable in the context of the method of division. Division aims at predicates which are not further sub-dividable. The final predication in (6) is exactly such a predicate. Further it is the essence. No explicit reasons are given for this stronger claim, but perhaps what justifies it is that the division starts from the genus, i.e. the predicate that is mostly predicated in the what-it-is. Placing the subjects under the appropriate genus and dividing according to the rules of division guarantees that we get essential predicates all the way down and that the last predicate is the definition.

Nevertheless, even if (5) and (6) are justifiable, there is a further puzzling feature in the argument, namely the conditional underlying (2):[269] if a collection of predicates, φ, is not expressing the essence of a subject, S, then φ is a genus of S. Surely there must be predicates that satisfy the antecedent but not the consequent.[270] What rules out possible counter-examples? One possibility is that some restriction is built into the conditional, equivalent to the one at work in the first criterion namely that the only predicates considered here are predicates in the what-it-is. This remark re-iterates the puzzle that runs through the whole section. If the disitnction between essential and non-essential predicates is assumed in the above discussion, what are we to make of the promisory note that *APo.* II.13 will treat the

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[267] (3) is a matter of definition: genera are ontological predicates of a number of different species. What makes them genera is that they are divisible into different sub-kinds. It follows that they extend further beyond any one of these kinds or species. I consider (2) below.

[268] This is implicitly assumed throughout the first section.

[269] Premises (5) and (6) do not attack immediately (1). Aristotle derives (4) from (1), (2) & (3) then he uses (5) and (6) against (4), in order to attack (1). This can only be done if (2), the conditional, is unobjectionable. If not then the argument challenges (4), while leaving (1) intact.

[270] E.g. predicates that are neither the essence nor a genus of the subject, but necessary predicates extending further than the subject. See also Barnes (1994:241-2) who seems hesitant on whether Aristotle makes an implicit assumption here. His interpretation is discussed below.

question how is it possible to hunt elements on the what it is of the subject?[271] So let us look to the conditional in (2) in more detail.

According to Barnes the criteria, in 96a24-31, that predicates A_1, A_2,...by means of which a term S can be defined must satisfy are the following:

(I) every S is A_i;
(II) for some S' distinct from S, every S' is A_i; and
(III) for all S' distinct from S, if every S' is A_i then S and S' belong to the same kind (i.e. they are species of the same genus).[272]

The essence of S, according to Barnes, 'is a conjunction, ϕ, of predicates where first each Ai satisfies (I)-(III), and secondly ϕ belongs to S.' This does not yet imply that ϕ is the unique essence of S. There might be a predicate B such that B is distinct from each Ai in ϕ and B satisfies (I)–(III). Then ϕ+B satisfies all the requirements for being the essence of S, and constitutes an alternative essence of S. According to Barnes Aristotle avoids these counter-examples by holding that one 'ceases collecting A_i's at the first point at which their conjunction has the specified properties'. (1994:230) But even this amended conception is vulnerable to counter-examples: 'suppose that we have picked A_1, A_2, ..., A_{n-1} (call it ϕ'); and that ϕ' & A_n (=ϕ) and ϕ' & B both have the specified properties; how can we choose between these two alternative essences?' (1994:230) Barnes argues that we can do so only if there is a priority between predicates such that 'first' refers not to the order of our selecting the A_i's but to some objective ordering of them. Otherwise any one of the two predicates, A_n or B, could qualify as 'first'. Barnes takes it that establishing such an order is one of the main aims of the chapter. The order to be established is of the following kind:

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[271] On the one hand, the opening section assumes that the definer is safe from including necessary non-essential predicates in the definition. On the other, the purpose of II.13 is to tell us how to hunt for the essential predicates expressed in definitions. However, the evidence from ll. 96b1-5, and 96b5-14, suggests that Aristotle never questions whether the complex predicate is indeed predicable in the what of the subject. The first argument concludes that all those predicates belong of necessity to the subject while it assumes that they are predicated in the what-it-is of that subject. The second concludes that these predicates constitute the nature or essence of the subject. Again this argument assumes that the predicates in question are predicated in the what-it-is.

[Aristotle] is assuming that the A_i's that satisfy (I)–(III) are arranged in an ordered set ψ<A_1, A_2, ..., A_n, ..., A_m>. Let ϕ_i be the ordered set < A_1, A_2, ..., A_i>. Then ϕ_n, according to 96a33, gives the essence of S if $Sa\phi_n$ and for no $j < n$ $Sa\phi_j$. ϕ_n is now (96b12) called "the last such predication to hold of the *atoms*": if we ran back through the ϕ_i's starting at ϕ_m, ϕ_n will be the last set which fails to satisfy (II). (1994:242)

If we substitute the predicate 'number which is odd and prime both as not being measured by numbers and as not being compounded by numbers' with ϕ_n then ϕ_n is the essence of the triad iff there is no number, N, distinct from 3 such that N aϕ_n. So the ordering for ψ, i.e. the ordered set that includes the essential predicates of the subject, is that of subsumption.[273]

However, this explanation, as Barnes himself notes, does not offer a justification to the assumption that the set of predicates is ordered by subsumption. (1994:242) There is no guarantee that a series of predicates ordered according to subsumption gives the essential properties of a subject. Secondly, even if the above interpretation is right it needs to be supplemented. The above requirements assume that S and S' if they turn out to be different, they are different *species* of the same *genus*. And this assumes their common genus is already fixed. Then the question whether the predicates hunted are essential or not is reduced to the questions how the genus gets fixed and how different subjects in it are distinguished.

An answer to these questions cannot appeal to essential predicates, since this will be circular.[274] Such an answer that suggests an independent justification of the assumptions of the method specified in the text, can be sought in the remarks made in the *Topics*. There Aristotle divides essential from non-essential predicates depending on whether they are predicated of a subject in the first figure of predication, i.e. in the what-it-is, or not. What is mostly predicated in that figure is the genus. The study of differences and similarities as a

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[272] Barnes (1994:241). He also notes that in the light of the argument of 96b1-5 for the claim that all elements in the essence belong to their subject by necessity, the necessity operator should be added to each of the requirements (I)-(III). This complication does not affect what is said here.

[273] Thus if the predicate ϕ_n is not the essence of the subject, and if it is not the case that ($Sa\phi_{n-1}$), ϕ_n must be extending wider than S, and so it makes sense to say that it is a genus of S.

tool for formulating definitions must begin with subjects, primary or not, under one genus. Similarly the method of division, described in II.13, begins by first positing the genus. How should the study proceed in order to capture the essential predicates is the task of the injunctions expressed in II.13. What this suggests is that given that one follows the rules for (a) establishing a common genus of a number of subjects, and (b) the steps exposed in the following sections of II.13, one is able to discover the essential predicates.

This proposal may be in contrast with reading the opening phrase of II.13 as promising a clear statement of necessary and sufficient criteria for dividing essential from necessary non-essential predicates. The aim is not a test such that given any set of predicates of a subject it will help deciding which ones are essential and which ones are not. Rather the method helps picking out one by one and in the correct order all the essential predicates of a subject, once its genus is fixed. The method shows what is the right way in proceeding when picking out the predicates in the what-it-is, and this method is presented in the following sections of II.13. So the focus is on what is the correct path for the investigation when one is in the course of picking out the essential predicates, i.e. when making divisions of the established genus. For Aristotle takes for granted that one investigates for definitions of a number of subjects under a common genus. If genus is the most important essential element of a subject, then it is assumed that by grasping the genus one has a grasp of the essence in its more general aspect.[275] The definer is somehow already in the path of grasping the essential properties of the subject,[276] and the predicates arrived at can only be essential ones.

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[274] In other words there is nothing wrong if the conditional that 'if a collection of predicates, φ, is not expressing the essence of a subject, s, then φ is a genus of *s*.' assumes that the definer picks out only essential predicates as long as such an assumption is justifiable on independent grounds.

[275] This is also assumed in *APo.* II.8.

[276] The definer deviates only if he violates the rules/criteria that will be proposed. The hunting metaphor, or at least one aspect of this activity seems to favor this reading. Hunting is for a particular kind of things, and it implies knowledge sufficient to discriminate what one is hunting for. The metaphor does not constitute strong evidence. It is already used in the Sophist 221C with respect to divisions. Pellegrin argues that the use of the verb indicates that Aristotle speaks here of an activity whose outcome is uncertain and which is often foolhardy. (1981:178-9)

So this suggestion can offer some justification for the conditional underlying (2), that blocks counter-examples.[277]

Even if the above suggestion is correct, it needs to be amended with respect to the criteria for hunting the elements in the definition. For the criterion of subsumption is unsatisfactory, since the chief example from our passage does not follow this criterion:

> Such things must be taken up to the first point at which just so many are taken that each will belong more widely but all of them together will not belong more widely; for necessarily this will be the nature of the object. E.g. number holds of every triplet and so do odd and prime (in both ways – not being measured by number and not being compounded from numbers)[278] (96a32-35; Charles' tr.).[279]

The differentiae of the genus number that are collected as essential predicates of the *definiendum* are odd and 'prime+'. What relates these two predicates is not subsumption, since odd does not subsume prime in either of the two senses of prime introduced here.[280] So the mathematician cannot be following the rule of subsumption in formulating the definitions.

An alternative to the subsumption interpretation is offered by Charles. Where Barnes takes it that Aristotle assumes that priority and posteriority are determined by subsumption,[281] Charles takes it that the definer relies in the order of derivation

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[277] On this reading, there is no circularity in assuming what it is to be an essential predicate, since this is obtained by means of some requirements of this method not clearly spelled out here. The arguments do not aim in showing how exactly we pick out the predicates by successive divisions of the genus, but only whether, once the predicates have been picked out, the complex predicate is necessary and the whole of the essence of the subject.

[278] I will be using Charles' abbreviation 'prime+' to refer to being prime in both ways.

[279] Aristotle then proceeds with the above two arguments aiming to prove (1) that all the above predicates necessarily belong to the nature of the subject, and (2) that no other predicate belongs to the nature of the subject. If he can prove these two claims, he can deduce that the proposed definition is, of necessity, the nature of the subject. These arguments and especially the second depend on the interpretation of the 'last predication' in l. b12. This ''last predication'' requirement (LPR from now on) must somehow have the same reference with the prescription made in line a34-5 that the set of terms, that are taken to belong essentially must when taken together be uniquely true of the kind in question. This requirement points to the fact that subject and predicate are co-extensive (CER).

[280] The point that this is not a definition by means of a wide genus and successively narrower differentiae is also made by McKirahan. The three differentiae 'do not identify successively narrower sets of things.' (1992:115)

[281] Charles presses the two questions we faced above, namely (1) how is the relevant genus itself determined and (2) how can one determine which sub-set of the necessary properties of the subject is the set of essential properties of that subject. (2000:225) Charles points again to lines 96a33 and 96b12 where Aristotle puts forward respectively the requirement that subject and predicate must be

characterising the practice of the mathematician that determines priority here. Charles' answer to the question 'why is odd prior to prime+?' starts from the following asymmetry between the two predicates:

> Knowing which numbers are odd is a step in a mathematical procedure towards discovering which are prime+, while knowing which are prime+ is not a step in a procedure towards discovering which are odd. This order of derivation justifies placing odd higher than prime+in the list of differentiae. (2000:227)

Odd precedes prime in Euclid's definition of features of number for the following reasons: (1) given a list of odd numbers one can extract the list of those which are prime (by means of 'Eratosthenes sieve');[282] (2) if one knows that the only prime numbers in the sense that they are not the sum of two numbers are 2 and 3, (3) then one can derive prime+ numbers by comparing the two lists.[283] This suggests that the ordering of essential predicates is neither based on subsumption, nor on any arbitrary selection of the differentiae that divide the genus. The division is conducted according to the explanatory practice appropriate to the genus under which the subjects fall.[284] And this points to a further feature. The definer in assuming the common genus also assumes the explanatory and derivational practices that can reveal the order of priorities within this genus. The following section of II.13 points to that direction.

3. Genus and explanation (Section 2: II.13 96b15-25)

The passage at II.13 96b15-25c is one of the most controversial passages of the whole book:

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co-extensive and the requirement that the predicate must be the last predication true of the individuals that fall under the species. He agrees with Barnes that the two requirements suggest 'an ordering of terms which, if followed will enable one to arrive at a point from which one can *first* capture (e.g.) what it is to be three.' (2000:226). Subsumption is understood here as the case where all members of a lower group belong to a group higher on the tree. This must be modally qualified, since the relation holds of necessity.

[282] The way such derivation is presented in some detail by Charles (2000:227 with fn.9).

[283] So according to Charles the 'species prime+ odd numbers is marked out by a differentia (being prime+), whose status (and relative position) as a differentia is legitimised by its role in a general arithmetical practice.' (2000:227)

[284] In the case of the genus number one will follow the explanatory patterns appropriate to mathematics. Cf. Charles: 'what counts as differentia is delimited (but not wholly determined) by what is explained by the essence in the appropriate way' (2000:230).

When one deals with some whole, he should divide the kind into what is indivisible in species (form), i.e. into the primitives, (e.g. number into triplet and pair). Then he should try to get definitions of these (e.g. of straight line and circle and right angle). After this having got what the kind is (e.g. whether it is a quality or a quantity), he should study the proper attributes through the primitive common terms. For the characteristics of the items compounded from the *atoms* will be plain from the definitions, because definitions and what is simple are principles of everything, and it is of the simples alone that the characteristics hold in themselves –they hold of the other items in virtue of the simples. (96b15-25)

A series of injunctions are put forward in ll.15-21, steps (1)-(4) below, while what follows ll. b21-5 seems to offer justification for step (4):

(1) First divide the genus/whole into entities atomic in sort, (e.g. number into triplet and pair),
(2) Assume (λήψις) definitions of those entities (e.g. straight line, circle, right angle),
(3) Assume what the highest genus is (e.g. quantity or quality),
(4) Consider the proper affections through the first common items (or: the first common items from the infimae species are proper affections (*propria*) of the genus)
(I) the attributes of things composed out of the indivisibles become evident from the definitions of the indivisibles,
(II) because definition and what is simple is the principle of everything, and
(III) [because] it is of the simples alone that the attributes hold in themselves –while they hold of the other items in virtue of the simples.

There are difficulties with most of the above steps.[285] In (1) things atomic in sort must be infimae species. However, the force of 'primitives' is not clear; does it refer to all or some of the atomic things? Definitions of these entities are formulated in (2), presumably by following the method outlined in the first section, and in (3) the highest genus under which the whole falls is fixed. The significance of this step is not clear either,[286] but step (4) is even more obscure since the reference of the nouns in (4) is uncertain.[287] Hence there is disagreement on how to understand the justification of (4) in (I)-(III).

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[285] See *Appendix II*, for a table summarising the interpretations that will be discussed here.

[286] Barnes wonders whether finding out under which category the genus falls is necessary for discovering its properties. (1994:242)

[287] What are the proper attributes which are studied through the primary common items? Are they (a) demonstrated attributes, or (b) the definitional predicates of the species of the whole genus? Further what are the primary common items through which the proper attributes are studied? Are they (a) common axioms or (b) first principles that are ultimate premises for the demonstrations of the attributes of both the simple and the composite subjects of a science?

According to Ross the passage deals with genera/wholes whose species are related with priority relations because some species are simpler than others.[288] One needs to study first the definitions of the simpler or *primary* species. Then the injunction in (4) is that the properties (proper affections) of non-primary species are deduced from the primary attributes which are common to both the primary and the complex species. The latter are complex because they are composed out of the primary ones.[289]

Barnes objects to this reading on two points. First, there is no indication that the discussion here is limited to genera whose infimae species form ordered series as the interpretation requires, but rather it is more general. Second, the interpretation entails the falsehood that the properties of non-primary *infimae species* are all properties of primary ones. (1994:243) I come back to these objections below.

Further, Barnes rejects Ross's claim that the first or primitive common items are the predicates common between simple and complex species. For this does not explain the use of 'primitive' here. (1994:243) Barnes suggests two alternatives for understanding 'primitive' here. First as equivalent to 'first' in 96a33: the primitive common items are predicates that are part of the essence of the subject from which further, necessary but not

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[288] Ross follows here Pacius' interpretation. (1949:658-9) According to the commentators, the passage deals with the definitions of some intermediary kinds in between infimae species and the *summum genus*, while a24-b14 dealt with definitions of *infimae species*. (Philoponus (400, 31- 401, 32); Themistius (56, 3 ff.). What is atomic in sort refers to infimae species and it is by means of their proper affections that the definer discovers the differentiae proper to the genus. This last step is premised on the claim that the first common items that belong to the genus are derived from the definitions of the species. Ross objects to this reading for three reasons. First, in (4) πάθη, in the expression 'proper attribute' cannot refer to differentiae. It must refer to the 'consequential attributes of different species' which are deduced from certain attributes common to all species. Secondly, it is unlikely that Aristotle would link (a) 'things compounded out of the indivisibles' with genera and (b) the simples with the infimae species. It would be more natural for him to call the genus simple and the species complex. Finally, the hypothesis that the passage deals with the definition of intermediate genera, is doubtful given that the following section, 96b25-97b5, deals with definitions of infimae species.

[289] This is Ross's suggestion for (I)-(III). Ross illustrates his suggestion with the example of the species of the genus line, straight line and circle, out of which other species of lines may be composed, i.e. crooked lines and curved lines correspondingly.

essential, properties are derived.[290] Second as equivalent to the use proposed in I.10 76b10: the first common items are the common axioms out of which the affections of a subject, *S* are derived. The latter is his preferred solution, but as Barnes notes it gives no clear sense of 'primitive'. So this suggestion fares no better than Ross's in that respect.

With respect to the second part of the passage, (I)-(III) above, Barnes interpretation takes it that if one is equipped with the definitions of the derived terms (those compounded from the *atoms*) and with the definitions and the attributes of the primitive terms (*atoms*) one can derive the attributes of the derived terms.[291] Thus he summarises the whole passage thus:

(1) Pick out the *atoms* [infimae species];
(2) Prove the attributes of *atoms* [infimae species];
(3) For the attributes of non-*atoms* [non-primitive terms] will be deducible from these attributes;
(4) For attributes hold of non-*atoms* [non-primary subjects of predication] in virtue of holding of the *atoms* [primary subjects of predication].

As it is evident from the square brackets glosses the result is an argument that equivocates on the term 'atom'. Barnes argues that none of the three renderings can substitute atom throughout. *Atoms* cannot be throughout the infimae species because, (a), if *atoms* are infimae species throughout 'what is compounded from the *atoms*' in (4) must refer to the higher genus and this is unlikely.[292] Secondly, (b) it is impossible that the attributes belong to other things in virtue of their belonging to infimae species.[293]

With respect to (b) Barnes' objection holds only if *atoms* refers to all infimae species. It is possible, however, that it refers to the primary *infimae species* out of which the non-

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[290] These are the in-itself incidentals. Thus Aristotle's injunction is that the in-itself incidentals of a subject, *S*, are to be inferred from essential predicates of *S*.

[291] He illustrates this with a geometrical example: 'if we start from the definition of *isosceles* as *triangle with two equal sides* and if we know that triangles have 2R, then we shall easily demonstrate that the isosceles has 2R.

[292] But surely, against (a) what is compounded out of the atoms may be a genus, if genera are wholes composed out of their species as parts. (cf. *Met.* V.25)

[293] According to Barnes 'subject of predication' is a non-starter while there are two considerations against taking 'primitive term' as atom throughout. The examples of triad and pair are not primitive terms. Second it is not clear in what sense the primitive terms can be atomic in form as said at 96b16.

primary are constructed.[294] This is exactly the line taken by Pacius and Ross. Barnes refers to Pacius' interpretation according to which *atom* refers to a special type of species, but he objects that the discussion is not limited to genera whose species are structured in such a manner, and that the interpretation entails the falsehood that all properties of non-primary species are properties of primary ones.[295]

Barnes' objection, and much of the difficulty with the passage, arises from the consideration that there are genera which present a far more complex structure than that the genus number which is offered as an illustration here. In the latter case there is strict priority between primitive and derivative species. But this is not necessarily the case with other genera, e.g. animal kinds. Does this entail that what Aristotle says here does not apply to the latter cases? Not necessarily. Nor does this entail that where there is no similar division between primary and not-primary species, the method must apply in exactly the same way. So perhaps we should relax the reading of the passage in such a way that the points are applicable, with some modification to genera with differing structures. To do so we need to look at some of the *PA* remarks concerning definitions of animal kinds. Before discussing these remarks in the next section, let us make a few points that allow for a deflated reading of the passage.

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[294] Further, even if atoms refers to all the species it is still possible that attributes hold of other things in virtue of holding of infimae species if the dependency here is subject-hood dependency.

[295] Finally Charles interpretation is that in (1) the definer selects the first, presumably basic or primary, atomic species of a genus. The proper affections are differentiae, i.e. essential features of the subject, and the first common elements from which proper affections are derived are the atomic species in whose explanation-involving definitions the differentiae were included. Relevant differentiae emerge from consideration of the explanation involving definitions of the first... elements in the domain.' (2000:231) Not all differentiae of the genus are differentiae, essential predicates of the atomic species. It may be that the 'relevant features... belong to the derived species in accordance with (*kata*) the nature of the simples (96b24 ff.) even though they are not all properties of simples. (2000:232) Charles also addresses the point that this interpretation does not show how the differentiae of not primary species can be derived from differentiae of the primary atomic ones, since it is not the case that all the properties of the former will be properties of the latter. His suggestion is that it is not that primary and non-primary species share the same affections, but rather that the affections of the non primary ones can be deduced from combinations of the affections of the primary ones. Charles offers an example where the properties of non-primary numbers, such as five, six etc. are derivable from the properties of the primary ones, pair and triple, by using the different modes of composition. (2000:232) His suggestion answers Barnes' objection to Pacius' interpretation.

First let us consider items that are indivisible in form in l. b16 and which are qualified as first or primary. In the case of the mathematical examples it may be relatively easy to determine the reference of 'primary' based on the priority relations holding within the corresponding genera. What about genera which do not display a similar kind of priorities? In these cases there will be entities indivisible in form, but no primitive/derivative division will apply to these entities.

Secondly, with respect to the common primitives and the proper affections derived from them in ll. b20-21. The primitives are common between a number of different subjects. But common is ambiguous between (a) a characteristic shared by a primary and a derivative subject and (b) a generic characteristic which is common to some or all of the species inside a genus. In (a), what is a common primitive will depend on priority relations such as the one exemplified in the relation between the attributes of line and plane. In (b), what is a common primitive will depend on priority relations that hold between the first common predicate, i.e. the genus which is mostly predicated in the what-it-is, and lower common predicates.[296] This ambiguity of 'common primary items' leaves the reference of 'proper affection' relatively vague, for what a proper affection is depends on what the first common items are from which affections are derived. But this accords with the use of the word *pathos*, which is used in a variety of ways. In the *Analytics*, it is referring to (a) predicates appearing in the conclusions of syllogisms, i.e. derivative ones, (b) differentiae, such as odd and even, (c) basic natural characteristics derived from bodily signs, and even to (d) essential properties or elements in the definition.[297] So if we were to restrict the scope of the expression, it should

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[296] It is not specified whether the common firsts are prior with respect to us, i.e. prior to perception or prior *simpliciter*. (71b33-72a5) We need not read the occurrence of first here, as prior by nature, in the light of the primary infimae species of l.b16. For here it is not the priority of, some, species but the priority of some common items (and there are genera where there are no such primary species).

[297] The word is used both in the *Analytics* and elsewhere, with a variety of referents. So, perhaps the use of this vague word tells against a restrictive interpretation of the predicates referred to. It is used in at least five passages within the *Analytics* (see below (1)-(5)). In (1) it refers to natural capacities which are derived from bodily signs. In (2) and (3) it refers to predicates appearing in the

rather be restricted to derivable predicates, i.e. to non-essential predicates derived from essential ones, whatever the exact structure of the priority relations inside the subject genus is.

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conclusion of a syllogism. In (4) it refers to differentiae, while in (5) it refers to definitory elements. *Met.* V.21 on *pathos* the treatment is brief and equally vague.

(1) In *APr.* 70b7 ff. there is a contrast between attributes (πάθηματα) that are natural characteristic (e.g. natural affections that change the body and the soul together) and acquired characteristics or capacities (e.g. becoming musical). The aim is to show that natural affections of the soul can be inferred from the presence of corresponding bodily signs. So 'if for each change there is a corresponding sign, and we could state the affection and sign proper to each kind of animal, we shall be able to infer character from features.' (70b13-4) The expression 'affection proper to a kind' is identical to the one in *APo.* II.13, but here it refers to a characteristic that extends further than the subject it belongs to. This is supported by the concluding lines of the chapter: 'To judge character from features, then, is possible in the first figure if the middle term is convertible with the first extreme, but is wider than the third term and not convertible with it: e.g. let A stand for courage, B for large extremities, and C for lion. B then belongs to everything to which C belongs, but also to others. But A belongs to everything to which B belongs, and to nothing besides, but is convertible with B.' (70b32-7, Jenkinson's translation) Courage here is an affection proper to the kind lion, without it being either a differentia of that kind of animals or a unique characteristic of them.

(2) According to *APo.* I.7: 'there are three things involved in demonstrations: one, what is being demonstrated, or the conclusion (this is what holds of some kind in itself); second, the axioms (axioms are the items from which the demonstrations proceed); third, the underlying kind whose attributes –i.e. the items incidental to it in itself – the demonstrations make plain.' (75a39-b2 Barnes' translation). Here the expression refers to the predicate appearing in a conclusion.

(3) In 76a13 Aristotle refers to attributes that hold of something in virtue of itself: ''we understand something non-incidentally when we know it (a) in virtue of that in virtue of which it holds and (b) from what are its principles as such.'' According to the illustration we understand that ''having angles equal to two right angles'', A, holds of something non-incidentally, a certain kind of figure, C, when we understand it in virtue of a middle term B, in virtue of which A belongs to all Cs, and as a result of more primary propositions true of B as B (see Ross (1949:537); Barnes (1994:135)). The proper attribute is the predicate appearing in the conclusion and holds of that subject in a proof where the middle term is that in virtue of which the predicate of the conclusion belongs to the subject of the conclusion.

(4) In *APo.* I.10 Aristotle discusses the first principles of each science. Sciences such as geometry assume what a unit or what straight and triangle is (76a35). These are items proper to each science whose existence as well as definitions (i.e. that they are such-and-such) is assumed (76b1-6). 'As for the attributes (pathe) of these items in themselves, they assume what each means –e.g. arithmetic assumes odd or even…'

(5) Finally in a difficult passage from *APo.* I. 28 87a39 which bears the closest similarities to our passage. *APo.* I.28 deals with what constitutes the unity of a science: 'A science is one if it is concerned with one kind, i.e. with (a) whatever items are composed of (b) the primary elements and are parts or attributes of (c) these in themselves.' It is not clear what is supposed to be classified under (a) and (b), and the reference of (c) is ambiguous between primary elements or derivative terms or both. Ross takes it that species come under (a), that the primary elements in (b) are either parts of the genus, i.e. species, or affections, i.e. essential properties of the species. Barnes takes the *or* as epexegetic and thus thinks that the parts are the attributes, in the light of *Met.* V.25 1023b23 claim that 'the items in the account which makes a thing clear are also parts of the whole'. He therefore takes 'these' in (c) as referring to the elements but to what the elements are parts of, namely the derivative terms. However, there is no need to read it as epexegetic. Parts may refer to the essential properties, while affections to some predicates which can be derived from them, as the II.13 passage suggest.

Thirdly, with respect to entities composed out of the atoms. As we saw Barnes argues that they cannot be genera and they cannot be derivative subjects composed out of primary ones. They cannot be genera because this would mean that genera are composed out of indivisible species and then their attributes would hold of them in virtue of holding of the species. They cannot be derivative subjects because not every genus has species ordered according to this kind of priority relations. Again I think we could read the passage without forcing one class of entities as the referent of either *atomon* or *suntithemenois*. In some cases the relation of what is primary and indivisible and goes into the constitution of something posterior and non-primitive will be a primitive subject such as the pair or the triple in the case of the genus number. In some other cases what is primary and primitive will be a genus to which the attribute belongs primarily. The genus goes into the constitution of the species, which in that sense it is more complex, and some predicates hold of the species in virtue of holding of higher genera that partly constitute those species.

Given the above points the passage can be understood along the following lines. The first common elements may, at least for some genera, be the highest common predicates inside a genus. This will contrast *first* here with *last* (ἔσχατον) in l. b13. A last predication is the lowest common element between a number of co-generic subjects, which cannot be divided into any lower more specific elements. So the suggestion is that one considers the infimae species' definitions of a number of species inside a genus. Then he takes the elements that are in common between different, overlapping, classes of such subjects. One establishes predication at the right level of generality. By considering these elements at the right level of generality one can derive proper attributes that belong to either the same level of generality or to lower levels.[298]

The above section of II.13 restates the importance of some characteristics already present in the *Topics*. First, defining is a comparative process. One must collect species

under the same genus, give some initial definitions, collect their similarities and derive further characteristics. Second it is crucial to posit the species inside the appropriate category. If, for instance, the species considered are falling under the genus of quantity, the definer will concentrate on the corresponding aspects of his subject, and not on qualitative or other characteristics they may possess that fall under categories other than quantity. These two points suggests that division has a role to play here. The next section is devoted to a discussion of the usefulness of division.[299] So the two passages must be closely connected and the method described in the remainder of the chapter must be clarifying aspects of the method sketched so far. Before considering this section, I will try to refine the above reading by taking into consideration some related remarks made in the *PA*.

4. Some methodological remarks in *PA* I.4-5 and APo. II. 13 96b15-25

An examination of Aristotle's methodology in biology and zoology needs a detailed discussion of *PA* I as well as a close examination of actual explanations in the biological works. Here I will only focus on some programmatic points made in *PA* I and try to show that some of them can be understood as a refinement to some aspects of the *Analytics* method. In particular some passages from the *PA* I.3-5 discussion concerning division offers indications concerning the interpretation of II.13 and the refinement of its injunctions when applied to biology. I will focus on the notion of a common nature between a number of species, which are therefore grouped together under a large kind. I will also try to make sense of the II.13 claim that the scientist derives attributes of the science by means of the common primitive predicates that belong to the genus.

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[298] This method may be closely related to the method described in II.14 98a13-19.

[299] According to Barnes divisions are useful for deducing definitions in the weak sense of 'computing' definitions. (1994:243)

One passage that gives some justification to the positing of such a common nature is found in *PA* I.4:[300]

> One might be puzzled why people have not named one kind that embraces both the water-dwelling and flying animals, comprehending both at once by one higher name. For there are some affections (πάθη) common both to these and to all the other animals. Nevertheless they are correctly defined in this way. For those animals that differ by degree and the more and the less have been brought together under one kind, while those that are analogous have been kept apart. I mean for example, that bird differs from bird by the more or by degree (for one has long feathers, another short feathers) while fish differs from bird by analogy (for what is feather in the one is scale in the other). But to do this in every case is not easy; for most animals have the same affections by analogy. (I.4 644a13-23; Lennox's tr.)

Aristotle defends the separate grouping of the kinds of water-dwelling and flying animals by appealing to the notions of analogical difference and difference by the more and the less. The latter kind of difference warrants the classification of the subjects that possess such differences under the same kind, because they share a common nature. The former kind of difference does not warrant the positing of such common nature. The two kinds of differences recall the two stages of the study of differences and similarities in the *Topics*. What exactly distinguishes the two kinds or degrees of similarity is controversial,[301] but the following puzzle offers some clarification. There is a dilemma whether one must study the natures of kinds of animals independently or according to common generic characteristics:

> [Puzzle:] Things that belong generally are common; for things that belong to many we call general. There is however a puzzle about which of these two should be our subject. On the one hand, in so far as what is indivisible in form is a substantial being, it would be best, if one could, to study separately the things that are particular and undivided in form- just as one studies mankind, so too bird; for this kind has forms. But the study would be of any one of the indivisible birds, e.g. sparrow or crane or something of this sort. On the other hand, in so far as this will result in speaking many times about the same affection because it belongs in common to many things, in this respect speaking separately about each one is somewhat silly and tedious.
> [Solution:] Perhaps, then, the right solution is this. In some cases –whenever kinds are spoken of by people in a clearly defined manner and have both a single common nature and

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[300] Although the expression common genus is not used in this fragment, it is introduced immediately afterwards. This notion seems parallel to *APo.* II.13's common genus of different species. Common nature is mentioned first in *PA* I.3 643a7-11 where Aristotle argues for the deficiencies of dichotomous division. There his point is that if there must be an indivisible differentia for each indivisible kind of animals there can be no common indivisible difference between kinds such as the ones posited by the dichotomist. [Lennox (2001a: 159)]

[301] See Lennox's on 'Kinds, Forms of Kinds, and the More and the Less in Aristotle's Biology' (2001b:160-181); Wilson (1997).

forms in them not too distinct –we should speak in common according to kinds, like bird and fish and any other there may be that, though it is unnamed, embraces like a kind, the forms within it. But whenever they are not such as this, we should speak one by one, e.g. about mankind and any other such kind. (644a27-b7; Lennox's tr.)

One point that emerges is that in the case of kinds that differ by the more and the less, and thus possess a common nature, the study must be conducted at the level of this nature. One reason is that going through the individual kinds that share this nature entails repetition. A stronger reason can be extracted from the *Analytics*, namely that certain attributes belong to the subjects in virtue of that common nature and thus their possession must be explained at this level of generality.[302] This idea is expressed by saying that one should look for primitive or first predications.[303] These first predications seem close to the primary common terms in the *APo.* II.13 passage. So the reference to common terms there may be an injunction for finding common elements between subjects at the right level of generality. By knowing predications at the right level of generality, one can search for explanations, since explanation will be found at that level. This suggests that the proper attributes of *APo.* II.13 may be exactly these explanations, i.e. that proper attributes are essential explanatory elements that can be derived by the elements they explain. Although this would not be an unprecedented use of proper attribute, this interpretation goes against most of the readings which equate proper attributes with demonstrated predicates, in-itself incidentals. A further alternative is that proper attributes are either demonstrable predicates at the right level of generality or at lower levels. It is conceivable that for deriving both these kinds one needs premises involving the primary predicates at the right level of generality. For it is at this level that possession of these predicates must be explained. But what warrants the idea of such a common nature in the case of living kinds?

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[302] So Lennox (2001a:170) who refers to the *Analytics* example of the triangle's attribute of having the sum of its interior angles equal to two right angles. The atribute belongs to particular kinds of triangles in virtue of belonging to the genus under which they fall. So in order to prove why it belongs to the particular kinds the proof must be conducted at the level of the genus. (I.4 73b25-74a3)

[303] I.4 73b40; I.5 74a3-6.

One explicit reason that warrants the idea that there is such a common nature, to which some attributes of the subordinate kinds belongs first or primitively, is that animal kinds are spoken of in a clearly defined manner. For the most part common usage is accurate in delineating the common natures of animal kinds. A further reason is that the delineation apparent in common usage relies, correctly, on morphological characteristics of the kinds or their parts.[304] So in some cases one must get hold of a nature that subsumes lower-level kinds, indivisible in form. This is a common nature indivisible in kind, and the explanation why the attribute belongs must be at this level of generality.

Nevertheless, differentiation according to parts is only one kind of division, and only a preliminary one. First, *HA* I.1 suggests further divisions of animal kinds with respect to manner of life, actions and character traits.[305] Secondly in *PA* I.5[306] a division of the corresponding causes must follow the division with respect to animal parts:

> It is necessary first, [a] to divide the attributes associated with each kind that belong in themselves to all the animals, and next [b] to try to divide their causes. Now it has been said before that many common features (πάθη) belong to many of the animals, some without qualification (such as feet, wings and scales and affections too in the same way) and others analogously. By analogously I mean that while some have a lung, others have not a lung, but instead something different which is to them what a lung is to those that have one;... To speak separately of each of these animals as particulars, as we also said before, will result in saying the same things many times, whenever we speak about all the attributes; the same attribute belongs to many animals. (645b1-14; Lennox's tr.)

The division in [a] aims at dividing features that belong to the generic common nature first and in itself, while [b] is a parallel division of their causes.[307] So [a] gives items that will

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[304] Aristotle speaks of the likenesses of the figures of the parts and of the whole body, between e.g. the members of the kinds of birds, soft-bodied, and hard-shelled animals: 'For their parts differ not by analogous likeness, as bone in mankind is related to fish-spine in fish, but rather by bodily affections, e.g. by large/small soft/hard, smooth/rough and the like.' (644b11-15)

[305] I follow Lennox's rendering of the greek nouns *bioi*, *praxeis* and *ethe* 487a10-12. In this passage Aristotle restates the point that his study will describe differences in the above respects in general outline, i.e. at the level of common generic nature and then at the level of the various kind.

[306] I.5 645b1-646a2 seems to be a continuation of the I.4 discussion, after a digression in ll. 644b5- 645a36. [Lennox (2001a:172)]

[307] Gotthelf (1997:218). There is a parallel to this passage in *HA* I.6 491a7-14. The *HA* passage makes the further point that this method of proceeding, dividing the causes, once the differences and attributes are divided, accords with nature (*kata phusin*). The reason that this method accords with the order of nature, is that in this way becomes evident what subjects our inquiry should deal with and from what principles or premises our demonstrations should proceed.

serve as *explananda*, the *explanantia* of which are the object of the division in [b]. One collects common characteristics at the level of common nature, and divides them, presumably, all the way down to the indivisible forms. Then he provides explanations for the items in this division. For instance, a division with respect to differences of bodily parts must be followed by a division of their causes. Since bodily parts are instruments for the sake of particular actions (645b15-20), their differences must be explained teleologically. These explanations will fit into a parallel tree dividing the causes for the sake of which the corresponding parts belong to their subjects. The explanations, of course, are not obtained by division, but the fact that they must fit in a parallel division, constrains the *explananda*, the sort of explanations one is looking for and offers a test for checking whether everything has been explained appropriately. Further, the two parallel divisions may be an instrument for establishing that the predicative relations and the differentiae suggested in the first division are sound, thus establishing the facts at the right level of generality.[308]

So the division of parts and attributes is vindicated by an explanation in terms of actions, and this is a general principle for the explanation of biological kinds and their parts. A further constraint is introduced in the following passage, where actions themselves are thought of as ordered in relations of priority:

> So it is clear, then, that whenever there are actions that are for the sake of other actions, the things whose actions they are differ in the same way that their actions do. Similarly if some actions are in fact prior to, and the end of, others, it will be the same way with each of the parts whose actions are of this sort. And thirdly, there are things that are necessarily present because others are. By 'affections' and 'actions' I mean generation, growth, coition, waking, sleeping, locomotion and any other such things that belong to animals; by parts I mean nose, eye, and the whole face... (645b28-35; Lennox's tr.)

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[308] This aim, fixing the level at which a part and its activity first belongs, is also stressed in the lines that follow: 'one should first discuss the actions -those common to all, those according to kind, and those according to form. I call 'common' those that belong to all the animals, and 'according to kind' those whose differences from each other we see in degree; for example, I speak of bird 'according to kind', but I speak of mankind, and everything without any difference according to its general account, 'according to form'. (645b20-26; Lennox's tr.) There is a gradation between different degrees of likeness and each level implies indivisibility. So animal characteristics, either parts or actions for the sake of which these parts exist, are similar or indivisible in these respects. It is perhaps curious that 'common' is reserved here for the level of analogous likeness, whereas in 644a27-b7 refers to kindred likeness. This constitutes some evidence that Aristotle believes that there are common functions at the analogical level. The contrary view is argued for by Wilson (1997).

The passage is relevant[309] to the methodological remarks in *APo.* II.13. Aristotle refers here to πάθη, cited together with actions, which are derivable from animal parts. Hence they must share at least one characteristic with actions and thus with what is explanatorily basic. They are both derivable from further characteristics of the kind. This re-introduces the thought that affections in the *APo.* passage may refer to actions or explanations in general, at least when the *APo.* remarks are applied to biology. They can refer to essential explanatory predicates which are derivable from derivable characteristics such as animal parts.[310] Even if one does not endorse this interpretation the passage suggests the flexibility of the term πάθος, and thus the general way in which it could be understood in the *APo.* context.

If so then the remarks at *APo.* II.13 96b15-25 may apply to the method hinted to in the above passage from *PA* I.5 in the following manner. The first common elements from which proper attributes are derived are animal parts according to which animals are differentiated into indivisible kinds. By establishing the common genus, one also establishes that parts are instrumental for the performance of certain activities or functions. Therefore, by considering the parts as first common elements, one can first derive their causes, i.e. what explains them as being parts of these organisms, in the sense of activities or functions proper to the kinds the parts belong first and in-themselves. Secondly one can derive proper affections, i.e. further non-essential derivable features. According to this process two co-ordinate divisions, each one of which may contain a plurality of lines, can be constructed. The activities serve as causal explanations of the possession of the parts, and the result will be some explanatory definitions of these parts and the natures corresponding to them. These natures will be at differing levels of generality with the most general ones being considered as simpler.

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[309] It is interesting that the passage describes actions at the same level of generality. What about the relation between generic and more specific activities? It is possible that certain specific activities are explained by more generic ones. This is not the stronger claim that all specific activities are to be explained by more generic ones.

(645b5-6) The complex natures of indivisible kinds are compounded out of the simpler and more primitive common natures. Thus by means of the explanatory definitions of the simple items, the definitions of the complex ones can be derived. This constitutes one plausible reading of the way the remarks of II.13 96b15-25 might be applicable to biology. Let us conclude the discussion of II.13 by turning to the section concerning the usefulness of division.

5. The usefulness of division (Section 3: II.13 97a23-34)

Aristotle sums up the method outlined in II.13 by distinguishing three main steps according to which definitions by division are obtained:

> For constructing a definition through divisions, it is necessary to aim at three things: (1) grasping the things predicated in the essence, (2) arranging these in proper order, and (3) [being sure] that these are all. (1) The first one of these is achieved through being able to establish things through the kind, just as in the case of incidentals one can deduce that they belong. (2) The proper arrangement will occur if he takes the first, and this will be the case if what is taken follows all, but all do not follow it –for there must be such a one. When this has been taken, the same method [is used] forth with for the terms below. For that which is first of the others will be the second and what is ['first'] of the subsequent ones is third. For when the thing above is taken away, the next one will be 'first' of the others, and similarly for the rest. (II.13 97a23-34; McKirahan's tr.)

The concluding lines of the passage equate what is first or primary with the more general predicates of the genus, and imply that this is a possible way of understanding primary in the 96b15-25 passage. But the most important piece of information relates to the steps, (1)-(3), of the method. First is the aim of grasping essential predicates, (1). It is not clear what is the similarity between the method of establishing the genus and the method of establishing that a συμβεβηκός belongs. Nor which sense of συμβεβηκός is at use here? Ross takes it that the common method is dialectical syllogism and that Aristotle is referring here to the *Topics*' accidents.[311] A plausible alternative is that the reference is to the study of differences and

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[310] Causes explain common or other attributes, and the same may be true of affections. If actions are derivable from common attributes, and the same hold of affections, then actions may be a sub-set of affections.

[311] According to Ross 'just as an accident can be established by dialectical syllogism (cf. *Top.* ii, iii), so can a definition, and this can be done through the genus, i.e. by using the *topoi* proper to the

similarities set out in *Topics* I.[312] Although the *Topics* do not offer an absolute principle for dividing essential from non-essential predicates, the study of differences and similarities is involved in constructing definitions, in detecting and collecting the essential predicates of the subjects studied. In doing so it relies on a grasp of predications in the first figure, i.e. essential predications. Distinguishing these predicative relations may not rely in any underlying set of criteria, and it may only involve some background assumptions implicit in the method for studying similarities and differences between subjects. At any rate the claim that essential predicates are established through the genus re-affirms the importance of the genus. Establishing that the genus is the single most important step in that direction. So (1) points to at least one of the basic claims in the *Topics*, as well as the study of differences and similarities. The connection with the latter is also suggested by the introduction of division in step (2).

The method of division as introduced in (2),[313] concerns the proper arrangement of the essential predicates. The class of essential predicates includes a *first* predicate, presumably the genus, that follows all other essential predicates of the subject, i.e. it is predicated of whatever subject the other predicates are predicated of.[314] This is the way in which the naturally posterior predicates entail the naturally prior ones according to the *Topics* and the *Categories*. Thus the order of the essential predicates here is that of natural priority.

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establishment of the genus to which the subject belongs (for which see *Top.* IV); for the differentiae are to be established by the same *topoi* as the genus (*Top.* 101b17-19).' However, *Topics* IV, dedicated to the study of genus sets out only 'an array of techniques for refuting or defending assertions that one thing is another's genus, none of which is at all helpful in deciding whether a proposed genus belongs to the essence of the definiendum.' (McKirahan 1992:113) Further, as Barnes points out it is curious that Aristotle does not refer here to the *topoi* from *Top.* V concerning definition.

[312] There is yet a third possibility: one can prove that an incidental predicate belongs to a subject through a middle term. Similarly one may be able to prove that something belongs as an essential property by constructing a syllogism that proceed through the genus.

[313] Barnes says that the first step, (1) of the method is not connected with division. (1994:236) But perhaps it is the very first step of the method or a necessary preliminary step of it.

[314] This reading follows the way natural priority of genus over its species was interpreted earlier. It differs from McKirahan's who suggests that here 'x follows y' iff 'x is predicated of y'. On McKirahan's reading the genus would not follow the differentiae since it is not predicated of them.

This point, however, does not address the two following problems. First, how do the predicates of the successive levels of the division form a unity? The second problem is this. On the one hand, the arrangement of predicates implied by step (2) comes in successive stages where the predicates at each stage are subsumed under predicates of the previous one, hence it assumes the criterion of subsumption.[315] On the other, as we saw when considering the definition of triple as 'number which is odd and prime+', subsumption does not always suffice for determining the ordering between the essential predicates of a subject. Subsumption may be the way predicates are ordered in a single line of division. However, this may not be the case where there are multiple lines of division, as for instance it is suggested in *PA* I.3-5. So, even if subsumption is true in some cases it is not true in all. Hence subsumption must be a sign of a further underlying reason of the priority relations between the essential predicates. Additionally subsumption may hold within each tree of division and not across different trees. The conjunction of these two claims can explain the definition of the triple as *odd, prime and prime+*. The differentiae are three different ways of dividing the genus number without remainder, they point to different aspects. Hence the priority relations that hold between them cannot be determined by subsumption. It is rather the explanatory structure of the subjects-genus that determines the order of priority.

Let us turn to the second problem. Divisions must satisfy the requirement that at each stage the differentia together with the genus must form a unity. (96b30-35, 96b37-97a4) Aristotle's injunction is that one must divide a genus by the *first* difference under which everything under that genus falls. (97a2) For instance, if animal is divided into split-winged

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[315] See Barnes (1994:236-7). On the subsumption reading, one begins by taking the first, and hence wider predicate from the set of essential predicates of a subject. Once this predicate is established one continues by applying the same principle and extracting the first predicate from the set of the remaining predicates. The same operation is carried until one reaches the very last predicate of the class of essential predicates. This final predicate is not predicated of nor entailed by any of the higher ones. Whether it is co-extensive with the subject is not clear. On the evidence of the earlier sections it is only collectively that the essential predicates are co-extensive with their subject. On the evidence of *Met.* VII.12 the last differentia is co-extensive with the subject. Against subsumption McKirahan notes that the 'passage assumes without proof that essential predicates of x can be put in an ordered sequence.' (1992:112)

and whole-winged, not every kind will fall under either one or the other of the two classes. By contrast, the two differentia would divide in a proper way, i.e. without remainder the kind of winged animals. Why is this way of dividing producing 'unities'? One way to understand the notion of unity here is through subsumption as the ordering principle that takes us from one unity to another during the process of division. If unity is understood in this way it amounts to say that one moves from unity to unity iff the correlative differentiae that divide a kind exhaust this kind. This is not a straightforward meaning of the term, and as noted above Aristotle's examples do not always obey subsumption. Before considering this problem let us turn to step (3) which seems to offer further evidence that the essential predicates are ordered by subsumption:

> And that these are all [the definitory terms that] there are is evident; for you assume of the first term in the division that every animal is either this or this, and that this belongs to it, and again <you take> the difference of this whole, and <you assume> that there is not further difference of the final whole –or that straightaway after the final difference this no longer differs in sort from the complex. For it is clear both that nothing extra has been posited... and that nothing is missing. (97a36-97b2; Barnes' tr.)

One has to (a) divide a genus in the ways specified above, i.e. by moving from unity to unity and taking as differentiae the *first* predicates at each stage of the division; and (b) continue this procedure all the way down until there is no other predicate that could differentiate in the relevant way the immediately previous kind. If (a) and (b) are followed, then there is no lower essential predicate missing from the collection, and since no intermediate step of the division was skipped no intermediate predicate is missing either. If this is the point then all essential predicates of a subject can be arranged in a descending order, such that each predicate is subsumed under the predicate one level up.[316] But it was argued that subsumption is problematic, and the proposal that the order of differentiating features depends on an order implicit in the explanatory practices of the science, seems preferable.

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[316] So Barnes (1994:247).

The main problem with subsumption is that the ordering it implies is sensitive only to the extension of the terms involved, rather than to any causal or explanatory relation. For instance, the kind of land-dwellers, may subsume biped and quadruped kinds as well as kinds with no appendages, e.g. snakes. The extension of the generic kind extends further than each one of the kinds subsumed. Yet the reason why it does is that (a) the above differentiae refer to characteristics that facilitate locomotion for land-dwellers, and (b) the nature that corresponds to these kinds is such that equips them with the best possible means for locomotion. From (a) and (b) it follows that land-dwellers can be differentiated in the above respects because they possess a locomotive capacity. Hence, in selecting the differentiae that divide land-dwelling kinds, one does not merely need to look for kinds subsumed under it, but to kinds demarcated because of the relevant determination of the common nature of land-dwellers.[317] If the priority relations are understood in this way we can make sense of the notion of unity. What unites the predicates at each level to the predicates one level up is the explanatory dependency of the former on the latter. The lower predicates are ways in which the higher more general ones are determined according to the explanatory practice of the subject genus.

That this is the direction towards understanding the priorities between predicates is confirmed, to some extent, by the concluding lines of II.13[318] and by II.14. Lines 97b8-25 describe the following method, and apply it to the example of a virtue, sc. magnanimity:[319]

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[317] This must also be one of the aims of the claim that the biologist should construct two parallel lines of division, one for animal parts and one for their causes. Some of the above locomotive differentiae will extend further than the kind of land-dwellers, e.g. the property of snakes of being footless which also applies to non land-dwellers. Yet the reason for not having feet in the two cases is slightly different (they share an analogical similarity). If the first division fails to grasp this difference, the examination of causes will make it evident and will help in correcting the first division. Classifying snakes together with kinds that are not land-dwellers would obscure this fact that relates to explanation, and it would have failed to offer the right sort of *explananda*.

[318] According to Barnes it is not clear whether the methodological points at the last part of II.13 are complementary or alternative to the method described so far.

[319] If we were to seek what magnanimity is, we should inquire, in the case of some magnanimous men we know, what one feature they have in common as such. E.g. if Alcibiades and Achilles and Ajax are magnanimous, what one feature do they all have in common? Intolerance of insult -one

(1) Take similar undifferentiated subjects S_1, S_2 ... S_n of *eidos* S under a kind K.
(2) Then take another set of similar and undifferentiated subjects S^*_1, S^*_2,... S^*_n of *eidos* S^*, different from S, but under the same kind K.
(3) Inquire whether what the $S_{1...n}$'s and the $S^*_{1...n}$'s have in common are elements such that a common definition, D_1, can be constructed.
(4) If there is such thing as D_1, then S and S^*, are one and the same, if not they are not one thing but several.

The application of (1)-(4) will possibly result in relations of subsumption between the subjects considered and the genus. However, the stress is not on subsumption but on a study of similarity and difference between a number of subjects under one kind. According to (1) and (2) different subjects, S, S^*..., under a common kind K are collected. One relies here on common usage. Then in (3) the similarities between the subjects with respect to their essential characteristics are considered.[320] If two subjects, S and S^* share all their features a common definition can be formulated, and thus it follows, (4), that S and S^* constitute one single species. If there is some difference no such definition can be formulated.

But the definer has done more than just that. First, the examples point to the discovery of a common *aition* between the two causes of magnanimity, namely indifference to good and bad fortune and intolerance of insult. Whether the acts produced by these causes form one class, i.e. they are subsumed under one kind, depends on finding a general common feature that explains these two more specific causes, in a way analogous to that in which intolerance of dishonour explains making war, waxing wroth and killing oneself. Whether there is such a common feature largely depends on the explanatory patterns appropriate for the subject-genus studied. This is what determines subsumption.

Secondly, in the case where the two sorts of magnanimity turn out to be one species, the definer has already collected the essential elements for formulating the corresponding

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made war, one waxed wroth, one killed himself. Next take some others, e.g. Lysander and Socrates. If their common feature is being indifferent to good and bad fortune, I take these two items and inquire what indifference to fortune and not brooking dishonour have in common. If they have nothing in common, then there will be two forms of magnanimity. (97b16-25; Barnes' tr.)

definitions. If on the other hand they turn out to be different, their differences will be the differentiae that divide the common kind into the respective species. So in searching for similarities the definer establishes a way of dividing the kind.[321]

Therefore the method described in the end *APo.* II.13 has affinities with the study of similarities and differences laid out in *Topics* I. In both works the study of similarities constitutes a complement to the method of division. Further, II.13 and *PA* I. 3-5 reaffirm the importance of the common genus in formulating definitions. Finally the concept of explanation, *aition*, introduced in *APo.* and *PA*, does not necessarily compete with the intuitions expressed in the *Topics*. They rather enrich and determine the earlier remarks. Therefore, the formulation of definitions as dependent on the derivational practices that correspond to the nature of the genus studied are not pointing to a radically different method of definition. They supplement and give a firm direction to the intuitions concerning definition expressed in the *Topics*.

6. Conclusion

The examination of *Topics* and *APo.* in the last four chapters displays some points of continuity in Aristotle's views concerning definition. In drawing the distinction between what is definitory and what not, Aristotle relies on classifying a number of subjects under the appropriate common genus, studying their similarities and differences and constructing the definitions by using the method of division.

On the other hand, the remarks in the two works suggest some development. The most crucial relates to the notion of explanation on which similarities and differences between subjects of a common genus are grounded, and on which the distinction between what is part

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[320] Barnes complains that this statement allows for too many non-essential attributes to be collected. But this objection is blocked, if by having established the common kind *K*, Aristotle believes that he has the resources to bar cases of non-essential attributes.

of the essence or the substantial nature of an entity and what is not. One result of this development may be that explanation becomes more basic than definition, at least in some respects, especially in the biological studies. Aristotle's method displayed in the biological practice of *HA* and described in *APo.* II.14 consists in the collection of counter-predications, and does not aim at divisions.[322] Aristotle aims at collecting a number of premises at the same level of generality, i.e. co-extensive facts about the natural world, irrespectively of whether the predicative relations are necessary or essential predicates. The *PA* will provide reasons explaining these facts. In that sense definitions, as conceived in the *Topics* model of genus and differentiae are not the aim of biology. Rather the aim is to collect clusters of counter-predicating terms and invoke explanation of the facts collected.

Nevertheless, this change of direction in biology need not be as radical as to reject the usefulness of at least some of the elements or instruments implied by his remarks in, what is considered to be, the earlier works. First the *PA* refers to common natures between animal kinds under a given genus and their study will involve division in one or more stages.[323] This is not in contrast with the view that the aim of Aristotle's biology is not classificatory. Secondly, although the biological studies do not aim at definitions of animal kinds but primarily to explanations, this does not mean that definitions or essences are foreign to these studies. First, because the notion of explanation as used in the *APo.*. is tied to that of definition itself. And further, explanation determines what elements constitute the core

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[321] The method as described above points to a bottom-up process for constructing a division of the genus, as opposed to a top-down division of the kind.

[322] However, in *PA* I Aristotle envisages a division of causes which parallels the division of parts of animals. This method will not lead to a detailed definition for each infimae species by means of genus and differentia, but it leads to some basic functions, most notably reproduction and nutrition, as the key in understanding the natures of biological kinds.

[323] The use of division will involve some assumption concerning common characteristics of these kinds. Secondly, the method involves assumptions concerning the kind of explanantia that can be employed in explanation in each subject-genus, in the case of biology teleological explanations. This may suggest some background assumptions concerning a common nature.

essential nature of a subject.[324] Secondly, because conclusions concerning the definition or essence of an entity follow from considerations regarding what elements constitute the nature of an entity, which are present in biology. It is fair to say that keeping track of the essential/non-essential divide is not the primary aim of the biological works. Further the introduction of the matter-form distinction re-directs the focus on the relation between the material and formal nature of living things. But this distinction is a division between elements that play a more basic explanatory role and determine the nature of a living thing and elements that are part of this nature more widely conceived. So the fact that biology does not focus on definitions does not discredit the essential/non-essential divide.

[324] Hence they determine facts about definitions. (*HA* 588a16, 589a1, 596b21-24; cf. Charles (2000:161). This of course does not mean that the biological works aim at definitions. It points to the further fact that the results of biological research would entail some claims concerning the natures or essences of biological kinds and thus for formulating the corresponding accounts.

1. Introduction: The Persistence of Natural Kinds

The account of definition and essence in the logical works imply that an investigation into the natures of organisms amounts to an investigation for the explanatory grounds that account for the features of those organisms. These explanatory grounds are primarily teleological. This is evident from the general way the concept of nature, and the class of natural things is introduced in the *Physics* as contrasted to the products of art. The comparison between art and nature in *Physics* II reveals a crucial asymmetry between the two cases. It is true of natural things, while false of artifacts, that

(a) what possesses the mature form must be an efficient cause as a principle of change for the generation of something with the same form, and
(b) the thing developing towards the fully developed form is the same (i.e. numerically the same and *a fortiori* it has the same principle of change) as the natural thing that possesses the developed form.

It was suggested, in ch. 1, that (b) could be derived from (a). But to do so some extra premise is needed. What this premise must be becomes clear from the following consideration. According to (a) the source of the process of generation that reproduces the form in another matter is the form itself (specifically and not numerically). This leaves open the possibility that the developing substance, undergoing the process, could be lacking the source that the fully developed natural thing possesses (exactly in the way that something possessing the mature form at the end of the generation process lacks the mature form while still in the process of generation). This would make generation of living things similar to the production of artifacts in the following respect: the thing that will acquire the mature form is a material substratum that underlies the change. If this were the case then two problems follow. First, the sameness asserted in (b) between developing and developed substance is violated for the former is identified with matter while the latter with form. Secondly, the development of the developed entity from the developing one suggests that it is not the form that is the active power in the generation of animals, but a causal contribution made by the

material substratum.[325] So (a) itself will be undermined. In order to avoid these two consequences one has to block the possibility that the developing substance, undergoing the generation process, could be lacking the source that the fully developed natural thing possesses. And this must be the extra premise for deriving (b) from (a), namely:

(c) the source or principle of change belongs to the developing thing primarily and in itself,

So the suggestion is that the claim that form in natural generation is the source of generation processes, i.e. (a), together with the claim that this source belongs to the thing that is in the process of being generated, i.e. (c), constitute the reason for the identity between developing and developed natural thing.[326] The identity between developing and developed living thing is thus based on two thoughts. The first is that the form of natural things must be an efficient cause for the generation of natural things similar in kind. The second is that the developing thing as identical to the fully mature individual it possesses the form of the kind as a source of change or as efficient cause. Since what is similar in art-production and animal generation is that in both cases what is produced is defined in terms of the final cause, it follows that in natural generation the form must exercise some efficient causal powers. Justification for both those premises can be sought in the arguments offered in the *GA*. The first thesis is less controversial than the second. Since it touches on the issue of the persistence of Aristotelian natural kinds, I shall refer to it as the Persistence of Natural Kinds Thesis (PNK). The second thesis is far more controversial. It relates directly to the nature of efficient causation in the generation of animals and to the question whether there is a non-formal causal chain sufficient for the generation of living things. Thus I will refer to it as the Sufficiency of Material Causes Thesis (SMC).[327]

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[325] The latter claim would run against Antiphon's principle that Aristotle endorses in Physics II.1, namely that the nature of an entity is what gets reproduced in generation.

[326] This is the second difference between nature and art, the first being that in living things that which generates is not a craftsman but something specifically identical to what it is generated.

[327] The reference to material causes might be thought misleading. For of course material causes are insufficient for producing living things. An efficient causal chain is needed as an active power. However, the question is whether this efficient causal chain is independent from form, or reducible to

Since this investigation is largely an investigation into the nature of efficient causation of animal generation I will focus on the *GA*. The *GA* opens as an inquiry into the efficient causes of organisms, i.e. an inquiry into that from which the source of movement of natural things comes (I.1 715a6).[328] So I will argue against SMC from the evidence found in the *GA* books (ch. 7). Before examining Aristotle's account of efficient causation in the *GA* is worth stating very briefly a general consideration that renders the denial of SMC plausible. There are two identity claims Aristotle explicitly holds. First, he argues for the identity between nature, as an inner principle of change, and form. (*Phys* II.1) Second, he identifies form with the final cause, i.e. that for the sake of which generation happens. By the transitivity of identity the inner principle of the generation of a living thing is identical with that which will be generated in the end. Yet at the same time the inner principle of change must be active during the generation of a natural living thing as an efficient cause that drives this process.[329] If the efficient causes were reducible to some material elements the same should be true of the form of the developed mature individual their activity brings about. And this consequence Aristotle denies.

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the active power of some substance such as the vital heat (in Lewis' terms whether this chain is *form-free*). If it is, then SMC is true. If material/efficient causes are indeed sufficient then the active power in the generation process is exhausted by the properties of the matter of the developing substance. I will argue that the *GA* evidence suggests otherwise. Furthermore, I believe there are theoretical constraints difficult to square with SMC. For if indeed SMC was true then this would entail that the form is not acting as an efficient cause in natural generation and this would place a gap between the developing substance, whose identity would be exhausted by non formal elements active in it and the developed one, whose identity depend on formal elements alone.

[328] The other three kinds of *aitia* have been discussed in the *PA* and *HA*. The final cause, i.e. that for the sake of which an animal exists, is identified with its essence, which is given in the account of its *ousia* or essence (*GA* I.1 715a3-5, 715a9-10). Teleological explanations are displayed in the *PA*. Matter, on the other hand, is identified here with the parts of animals. Thus the reference may be to both the *PA* and *HA*.

[329] Here the following puzzle arises: how can nature as an inner principle play these two roles? Does not this reduce final causes to some sort of efficient causes? If the efficient cause is some means for the end produced, how is it possible to identify the final cause, or parts thereof, with the efficient cause? What does this double role of nature entails for Aristotelian essences? Aristotle seems to be attributing to the principle of generation such a double role. He identifies it as something that is for the sake of the end (*GA* II.6 742a23-4), but he also argues that it is a part of the form or end. The principle resides, from the beginning of the generation process, in something which is a part of the end and the first part to be formed (742a32-34), the heart in the case of sanguineous animals or what is analogous to it in non sanguineous ones. (742b38-9) So the principle is on the one hand an active efficient cause

This suggests some preliminary reasons for the falsity of SMC. However before examining this in detail in the next chapter, an examination of the first problem concerning the persistence of animal kinds will clarify some issues concerning teleology in the natural world which will be useful in examining the difficulties relating to the second problem.

2. Two principles concerning the regularity of copulation in the *GA*

The *GA* is introduced as an inquiry into efficient causation in the world of living things. This inquiry is identified in the outset with the inquiry into the generation of animals.[330] The formation of animals is a result of the copulation of male and female which are the two principles in the generation of animals.[331] The animals produced by the copulation of male and female are themselves either male or female, and hence they can copulate and produce offspring. The offspring produced in this way are identical in kind with their parents. (715a23-24) What confirms the identity in kind between copulating parents and generated offspring is that they both possess the same capacity for producing an offspring similar to them. Both parents and offspring can generate something with the same nature or internal principle of change. However, there are groups of animals 'which although they generate, yet they do not generate offspring identical with their parents.' (715a25) These are creatures

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forming the heart and the heart acts as a generative principle residing in the heart. On the other hand, the heart is a constitutive part of that for the sake of which acts.

[330] This identity is not surprising if nutritive soul is the source of both generation and development. [Balme 1972:127)]

[331] *GA* I.1 715a18-20. According to *GA* II.1 732a1-3: 'since the principle of these [i.e. of the kind of men, of animals of plants] is the ''male'' and the ''female'' it will surely be for the sake of generation that ''the male'' and the ''female'' are present in individuals which are male and female.' Some reasons for the separation of males and females in animals, by contrast to plants, are given in the subsequent lines. First, male is linked with the *logos* and the form, i.e. what is better and more divine than the matter which is linked with the female. (732a5-10) Second, although this is not linked, explicitly, to the separation of male and female animals but not plants possess the power of sense-perception. Third, the fact that animals have a capacity for locomotion is supposed to justify the separation of the sexes. Finally, the fact that some animals, those larger in size, are able to emit semen suggests that their nature is more self-sufficient than others, i.e. that they are capable of producing soul-heat of a greater power. (732a12-21) So it seems that separation of male and female is necessary where there is a complex of soul-faculties or capacities, and thus the need for a more powerful kind of heat to assist in the production of an organism equipped with these soul-faculties. The suggestion that larger and more mobile animals are more self-sufficient implies that the smaller are less self-sufficient. As we will see their generative capacities are inferior.

that are not the result of copulation but they come to be either out of putrescent soil or out of residues. (715a26-7) Aristotle explains this irregularity in nature in the following way:

> ... this is what we should expect; for supposing that creatures which are produced otherwise than from living animals copulated and produced living animals: if these products were similar in kind to their parents, then the manner of their parents' original generation should have been like theirs. This we may reasonably claim, because it is evident that this is so with all other animal. If on the other hand, the products were dissimilar from their parents, and yet able to copulate, we should then get arising from them yet another different manner of creature and out of their progeny yet another, and so it would go *ad infinitum*. Nature, however avoids what is infinite, because the infinite lacks completion and finality, whereas this is what Nature always seeks. (Peck's translation I.1 715b7-16)

The principle on which Aristotle's argument seems to rely is that the generation of a living thing of the same kind as its generating parents requires a generation process similar in kind to the one through which its parents were generated. Thus:

(P1) For a living thing, c_1, to be able to produce an offspring of the same kind through copulation, c_1 must be generated out of copulating living things, c_2, c_3, that came to be by a similar process of generation as c_1.

(P1) is the answer to the question why a creature that does not come to be generated out of the copulation of male and female cannot itself generate a living thing, male or female, which will then be capable of generating an offspring in a similar manner. The ground for holding (P1) seems to be the regularity characteristic of reproduction in the animal world. Aristotle's discussion offers support to something equivalent to (P1) by a *reductio* of its denial. He begins with a dilemma: if creatures generated out of residues were able to copulate and generate a living thing, c_1, that could copulate and reproduce, c_1 should either (I) be similar to its parents or (II) dissimilar. Then he tries to show that both horns of the dilemma involve impossibilities, and thereby to conclude that it is impossible for creatures generated out of residues to generate living things that could copulate and thus reproduce.

If the offspring was similar to its parents, then the parents could not come to be by a different process from the one that generated the offspring. This is evident, says Aristotle, from what happens in the natural world, i.e. that living things can come to be only by the same process that their parents came to be. Yet the parents in our example did not come to

be from the copulation of male and female. They were generated out of residues, which implies a dissimilarity between the two generation processes and therefore between the two entities. So the offspring cannot, after all, be similar to its parents. This renders impossible the first horn of the dilemma.

Then Aristotle offers a reason against the other horn, namely the claim that creatures that come from residues could copulate and generate living things dissimilar to them which in their turn could copulate and reproduce. If the offspring was dissimilar to the parents then, (I), the offspring, *qua* living thing, will be able to copulate and reproduce. Yet, (II), *qua* dissimilar to the parents it would generate something dissimilar to what the parents generated. Further, (III), this would go on *ad infinitum*. However, (IV), an infinite series of dissimilar creatures runs against the principle that nature always avoids the infinite and seeks an end. This is supposed to prove the impossibility of the second horn of the dilemma.

The argument can be questioned in at least two points. Is the conditional underlying (IV), i.e. that if there is an infinite series of generation of dissimilar entities the aim of nature is violated, well-grounded? Secondly is Aristotle justified in deriving (II) and (III)? Let us examine this question first, since if (II) and (III) are undermined, this casts doubt on (IV). So, why is it that the second creature in the series cannot generate something similar to itself against (II)?[332] The reason that this cannot be so, is that if the second creature could generate something similar to itself then the impossibilities involved in the first horn would apply. Let us see this in detail.

Creature *c1* is generated out of residues, by a process *g1*. Suppose *c1* is able to copulate and produce something dissimilar to it, say *c2*, out of a process, *g2*, which is dissimilar to *g1*. This is something agreed from the outset, for while *c1* arises out of residues, *c2* arises out of the copulation of male and female. Now if *c2* generates an entity,

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[332] The same point can be made with respect to (III). Why not assume that at some point during the successive generation some similar entity will come to be, thus initiating a series of similar entities

c3, out of a process, *g3*, then, Aristotle claims, *c3* cannot be similar to *c2*. According to (P1) similar creatures can be produced only by similar processes. So one way to secure that *c2* and *c3* must be dissimilar is to show that *g2* and *g3* are dissimilar. But what could offer support to such a claim? The only plausible candidate is the claim that only similar creatures can give rise to similar processes of generation, i.e. the converse of (P1):

(P2) Two token-generation processes, g_1, g_2, are of the same type, *G*, iff g_1, g_2, are initiated by pairs of copulating living things c_1, c_2, and c_3, c_4, respectively where the two pairs are similar in kind.

According to (P2), if *c1* and *c2* are dissimilar, *g2* and *g3* must be dissimilar. If *g2* and *g3* are dissimilar then, by (P1) -the principle that similar creatures can only come from similar processes-, *c2* and *c3* must be dissimilar. And if *c2* and *c3* are dissimilar, by (P2) -the principle that only similar creatures can give rise to similar processes-, the generation processes *g3* and *g4* to which *c2* and *c3* give rise must be dissimilar. If *g3* and *g4* are dissimilar, then by (P1) whatever is generated by *g4* cannot be similar to entity *c3* generated by *g3*. And the infinite series of dissimilar entities is on.

It is important to note that, (P1), the principle that similar living things must come from similar processes of generation is not enough to get the regress going. Something more is needed and the most plausible candidate is (P2), the principle that similar processes of generation can only come from similar living things. If Aristotle subscribes to the conjunction of (P1) and (P2), he believes that any dissimilarity in the process of sexual generation is impossible. Any deviation from the schema implied by the claim 'man begets man' creates, given the conjunction of (P1) and (P2), an infinite succession of dissimilar generations which give rise to dissimilar living things.

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and 'inaugurating' some regularity in the series of generations. I will focus on the question challenging (II) but the answer given in the main text applies to the question regarding (III) as well.

Let us now turn to what justifies claim (IV) above, i.e. to what makes such a series impossible.[333] The infinity of successive generations of specifically dissimilar living things is said to be impossible because the infinity implies that there is no end or completion in this series. Since nature avoids infinity by always seeking some end, such an infinite series is impossible in natural generation. (715b14-6) But now although the infinite series may lack an end in the sense that it is never complete, since a new kind of entity is generated at each stage, the successive generation processes do not necessarily lack an end in some other sense. Nothing entails that there are no final causes operating in each generation process. After all each one gives rise to an entity which will develop into a mature individual of some form or other, as mature as any other in the series. So, perhaps it could be argued that each generation will be directed towards the corresponding form as an end.[334] Further, even if a teleological account of their generation process is in doubt, still spontaneously generated creatures are of a particular nature, fall under some natural kind or other, and teleological explanation is applicable to an analysis of their parts. Aristotle cannot be denying this. Why does he claim then that their natures are in contrast with nature's tendency to seek an end and avoid infinity?

One suggestion is that different notions of an end are employed here stemming from a stronger and a weaker understanding of the nature of a living thing. In the stronger sense only constantly persisting natural kinds count as possessing a nature. Their form or end is also an efficient cause reproducing by a repeatable process the individuals falling under the same kind. By contrast unnatural generation can be said to be 'by nature' in a weaker sense since although it is directed towards a natural kind form, it is determined by the surrounding conditions and the material involved in the process. But these material determinations do not

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[333] As Balme notes the argument does not directly rely on infinite regress, because 'the notion of an endless series of different offspring is not logically absurd.' (1972:29) It is impossible because such a series would lack an end which would hypothetically necessitate it.

give rise to constant regularities such as the ones displayed in sexual generation. So in the strong sense nature involves the reproduction through sexual generation of creatures similar to their generating parents thus conforming to principles (P1) and (P2). In this sense only reproduction counts as generation. This is the way to achieve an end and thus avoid infinity. In a more relaxed sense even the natures of spontaneously generated entities have an end in the sense that some teleological account of the functioning of their parts can be given.[335]

In order to get clearer on the distinction between sexually and spontaneously generated living things we need to look at the account of spontaneous generation in *GA* II.11 (see *Appendix* III). For the moment we can attend to a crucial difference between the two kinds of processes. In sexual generation there is a division of labor between active and passive powers in the male and female contributions. There is also evidence for differences in the kind of vital heat involved in the generation processes characteristic of each animal kind.[336] In the case of spontaneously generated animals no distinction between active and passive powers is straightforwardly given. Indeed in *GA* III.11 Aristotle distinguishes between the elements that play the respective roles. (762a36 ff.) However, there is no clear differentiation between kinds of vital heat corresponding to each kind of spontaneously generated animals. The heat of the surrounding air or water plays an active role in determining the outcome.[337] Thus in spontaneous generation there is a degree of indeterminacy regarding the active and passive powers at work which does not allow for a teleological explanation similar to the one that applies to cases of sexual generation. And this suggests that final causes are operative in sexual generation in a way that does not apply

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[334] One could think of a parallel infinite series of dissimilar artifacts, the first of which is constructed by a craftsman and is capable of initiating an infinite series of generations of dissimilar artifacts.

[335] So it could be said that some end is achieved in their case as well. The above distinction need not be an absolute one and there might be borderline cases. See, for instance, the discussion of testacea in *GA* III.11 761a14 ff. which are somewhere in between kinds of plants and animals.

[336] *GA* II.1 732b26 ff. is often read as suggesting such an explanation of the differences.

[337] The heat involved in spontaneous generation has according to Gotthelf an undifferentiated potential for form. See *GA* III.11 762a18-27, esp. a26 and Gotthelf (1987:181-193). Aristotle's account and Gotthelf's interpretation are discussed in detail in *Appendix* III.

to spontaneous generation. This then may be what Aristotle means by denying finality in cases of spontaneous generation.[338]

The above suggestion is plausible given the claim that generation in the natural world is reproduction, which Aristotle explicitly endorses. In *Physics* II.1 Aristotle endorses the principle, attributed to Antiphon, that the nature of an entity is that element common between the ancestral and the generated entity, or between parent and offspring. Aristotle argues that the reproduced element is the nature of the entity as an internal principle of change. If there is no element reproduced, there is no internal principle of change. So, there is a nature (in the strong sense) and natural generation, only where there is some element reproduced in the process. This is the principle of the generation both as source and as a limit/end of the change. Natural generation presupposes the similarity, in that respect, between parent and offspring. And this is exactly what is denied in the scenarios of an infinite series of dissimilar creatures.[339] So the reason why this generation is not considered as having a final cause is the difference between a living thing produced in this infinite series of specifically dissimilar generations and a living thing produced in an infinite series of specifically similar ones. What the former lacks and the latter has is the ability of the

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[338] Another possible, and compatible, suggestion is to understand the impossibility of an infinity in the case of unnatural generations as closely connected with the impossibility of an infinity of generations in a straight line which happens of necessity, i.e. eternally. According to the argument in *GC* II.11 337b25-9 an infinite series in a straight line cannot have an *arche* (grounding). (338a6-9 and Williams (1982:204)) From this premise Aristotle concludes that there would not be a member of the series on account of which it will be necessary (*simpliciter*) for the series to come to be. So it cannot be eternal. If, given such a series, there can be no generation which is necessary *simpliciter* then there cannot be eternal generation either.

[339] The same sort of impossibility is implicit in the *GC* where Aristotle argues for the necessity *simpliciter* of some generations in the natural world. According to *GC* II.11 338a8-11 some generations (e.g. generation of living things) take place of necessity if (a) the series of generations being considered is infinite, (b) there is nevertheless an *arche* of the series, and (c) the generations which make up the series are cyclical. Infinite in (a) must be understood in a different way from the way in which non-sexual generation is said to be infinite, i.e. probably as meaning unlimited in number (not in form). The idea suggested by the conjunction of the three premises is that there cannot be an infinite series which has a principle and does not display the recurring periodic structure implied in (c). If it were it would be limitless in the sense in which non-sexual generation would be limitless. (cf. Lennox (1985:73)) However, an appreciation of the points concerning reproduction and the permanence of the species in the *GA* require a close investigation and comparison with the arguments of the *GC*.

generated organism to be the efficient cause of the generation of a specifically similar organism. Hence if a natural generation is to have a final cause, in the strong sense, this final cause must possess the power to initiate a specifically similar generation process. Given (P2), if these two generation processes are similar the living things that initiate them must be similar, and given (P1), if the two living things are similar, the processes that generated them must also be similar.

The above interpretation does not commit us in thinking that the nature always seeking an end is something over and above each particular nature belonging to each natural kind. The nature corresponding to each kind seeks an end in the sense that it seeks the generation of specifically similar living things from specifically similar generation processes. This end is achieved for some kinds, namely those that possess a nature in the strong sense. There are kinds whose nature, unable to produce this end, avoids infinity by avoiding an infinite series of dissimilar entities.[340] But what grounds the assumption that reproduction is the way in which nature seeks to avoid infinity? The assumption seems reasonable given the evidence of constant reproduction of living things in the natural world.[341] But this does not guarantee the truth of the principle. Some additional reason is needed.

Part of this reason may be provided by the following claims: (I) the generative capacities of living things are a constitutive part of their natures; (II) reproduction aims at some good; hence (III) the natures of organisms aim at some good, namely the good brought about by means of reproduction. Both claims (II) and (III) are endorsed in *GA* II.1 and *dA* II.4. Further, (II) and (III) entail that living things do not merely possess a reproductive capacity but aim at its exercise and thus reproduce their kind.[342]

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[340] If spontaneously generated animals were able to copulate the result would be such an infinite series of dissimilar entities. It could be suggested that nature avoids infinity in their case in the sense that there is no infinite series of dissimilar generation processes of dissimilar entities.

[341] See Cooper (1987:247-9).

[342] In other words, whatever exists according to nature aims at preserving its existence in full actuality, in whatever way it is possible for it. If, moreover, the conjunction of (P1) and (P2) is a

3. The value of being actually F

Let us first examine the kind of goodness related to the activity of reproduction. The argument in *dA* II.4 that examines the most universal of soul-faculties among living things (plants and animals alike), nutritive soul implies the claim that there is a value in *being an F*. The discussion begins with two methodological remarks. First, in order to identify soul-faculties one must begin with the activities and actions corresponding to them, activities that constitute the observable exercise of these faculties. (415a19-20) Secondly, the correlative objects of those activities are prior to their exercise so the examination of the objects must precede that of the corresponding activities. The functions that correspond to nutritive soul are reproduction and assimilation of food (415a22-3):

> The nutritive soul belongs also to the other living things and is the first and most commonly possessed potentiality of the soul, in virtue of which they all have life. Its functions are reproduction and the use [assimilation] of food; for it is the most natural of all function in all living things, such are perfect and not mutilated or do not have spontaneous generation to produce another like themselves -an animal to produce an animal, a plant a plant- in order that they may partake of the everlasting and divine in so far as they can; for all desire that, and for the sake of that they do whatever they do in accordance with nature. (*dA* II.4 415a23-b2; Hamlyn's tr.)

The intake and assimilation of food and the reproduction of an entity similar in kind are here taken as what is most natural for living things, provided their nature is not deprived. These are the two most basic life-activities of living things. Therefore, the capacity of which they are the activities, namely soul's nutritive capacity, must be the capacity in virtue of which living things have life. But what justifies identifying these two activities as the most natural ones is not just the regularity with which they occur in living things. They are activities directed towards self-preservation and what is distinctive about living things is that they possess in themselves the resources, the internal principle, that can enhance their persistence. Hence the exercise of these activities is what guarantees some form of persistence for individual organisms and the natural kind they fall under. Namely persisting in a state of full

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constraint in order to achieve this aim it follows that reproduction is the only way that conforms to nature's overall aim.

actuality (in which they can exercise any other capacities characteristic of their kind, relating to higher soul-faculties). This form of persistence is as close the kinds of living things can get to the eternal and most valuable form of persistence given the limitation of their mortality. Namely, having an internal capacity the exercise of which underwrites the exercise of all other natural activities characteristic of the kind. This capacity is what makes them natural living things. This provides the link between the nutritive/reproductive capacity and the nature of an organism.

With respect to the good, does Aristotle mean that existing as such is more valuable than not existing? That there is some goodness in persisting just for the sake of persistence? This would mean that Aristotle attributes value to the existential reading of being (i.e., to what is referred to by the incomplete form of the verb *to be*). Existence, however, like *entity* or *one* do not refer to items that fall under any one of the categories of being, they are syncategorematic expressions, and they must always by completed by a reference to an item falling under one of those categories.[343] If so then we should take the reference to being as meaning that *being an F* (where *F* ranges over forms that correspond to kinds under some category of being or other) is always better than *not being an F*.

This suggests a link between reproduction and the good. For reproduction aims at turning what is not an *F*, or is only an *F* in potentiality, the catamenia, into an *F* in full actuality, i.e. into a fully mature individual which is the same *F*, in kind, with the generating parent. Hence reproduction aims at the persistence of the form of *being an F* (actually), and to that extent it is for the better. This clarification throws some light to (II) above, namely the link between reproductive (and nutritive) activity and what is better.

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[343] See *Cat.* 4 1b25; *Met.* IV.2 1003a33 and V.7 1017a22-30. For *one-ness* see *Met.* X.1 1051b1-5, and also V.6 1016b22 f.: 'that which is one is not the same in every genus.' (where genus can be understood as a highest genus). Similarly in *dA* II.1 412b8-9 unity and being are said to have many senses, presumably as many as the categories. The most fundamental sense, however, is the relation of an actuality to that of which it is the actuality. It is not clear whether this sense is reserved for the category of substance or whether it applies to other categories.

But we could question this link. Why is it that *being an F* is more valuable than its contrary state? A positive reason for this stems from unpacking the expression *being an F* in the following way. It may mean something equivalent to being an entity which has a potentiality/capacity (the nutritive-soul) for exercising the function of nutrition and reproduction, and being able to exercise it. Thus *being an F*, must mean here *being an F in full actuality.*

One way to argue for the value involved in the exercise of nutritive and reproductive activities is that they constitute a mode of activity that approximates the order displayed by the eternal and the divine. This mode of being is displayed by the Unmoved Mover who is eternally in a state of full actuality. The argument will be, roughly, that the nutritive/generative activities allow for the maintenance of living things in full actuality, for as long as their mortal nature allows. These capacities are not only directed to their own exercise, but they support the exercise of any other capacities characteristic of the kind. This state of activity belongs necessarily, i.e. eternally, to some divine entity, and this is the reason why it constitutes some basic good in the natural world. So living things pursue the exercise of these capacities in order to partake of this good. Whether this view is correct the line is questionable in at least one respect. It makes the exercise of the natural activities of organisms dependent or conditional on some further good. The good displayed by some entity of a higher order or of the nature of the universe.[344] So I will not examine here whether the activity of the natural capacities of organisms is essentially dependent on their relation, whatever the exact nature of such a relation will be, to some divine entity.

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[344] With respect to the second possibility, i.e. that there is a universal nature such that organic forms are realised for its sake, Broadie argues that it is thoroughly unaristotelian because on that assumption there is no place for autonomous Aristotelian substances: 'the realisation of some given form is a goal served but not grounded in the natures of whatever physical objects behave in the appropriate ways. Are we now even entitled to think of these as having natures at all, in Aristotle's sense? For what he means by a ''nature'' is not merely a set of dispositions to behave in certain ways, but the inner source of behaviour.'(1990:394-5) A similar argument could be proposed against the first possibility, i.e. making the natures of living things conditional to the nature of a divine entity. A consideration of this claim demands a full discussion of *Met.* XII and related passages not possible to

Instead I will consider a different, though not necessarily incompatible, line suggested by the reference in the above passage to living things being in a completed or perfected state. The reference to completion here is crucial, for reaching completion is something intrinsically good. The different uses of *complete* are discussed in *Met.* V.16 and they revolve around two key ideas. The first is that complete is something from which no part, from those it should naturally possess, is absent. The second is that for something to reach completion is for it to reach the excellence corresponding to it. The uses outlined are the following three:

(1) a unity out of which there is not even one portion to be found. (1021b12-14; see also the equivalent definition of *whole* in V.25 1023b26)
(2) that which in respect of excellence and goodness cannot be surpassed relative to its genus. (1021b14-15)
(3) things which have reached their fulfilment or ultimate purpose. (1021b23)[345]

Use (1) is understood by the commentators, following Alexander, as a quantitative use of *complete*. (cf. Reale (1993:264)) In (2) *complete* is treated in the qualitative sense (cf. Kirwan (1973:167)). (3) is the relevant use linking completeness to things that have achieved their proper end in a way that covers natural living things.[346] Aristotle's comment links this end to something good: the things which have attained their end, this being good, are called complete; for things are complete in virtue of having attained their end. So, being complete is understood, in (3), as possessing an end by nature and having achieved it. (Ross

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undertake here. This line is criticised by Gotthelf's analysis of the good in Aristotle's teleology. (1987: 129-131) The opposite view is defended, most recently, by Sedley. (2001:327-350)

[345] *Telos* here is fulfillment, rather than end or last point. [Kirwan (1973:167)] Death, i.e. the terminus of life, is only thought of as a *telos* by transference and not in the sense discussed here, i.e. as fulfillment. Life's end in the latter sense is the zenith of life, the completion of a development. (1021b29-30; *Phys.* II.2 194a28-33) Thus (3) focuses on the fact that 'end' and 'that for the sake of which something exists' are identical.

[346] Finally in the summary of the chapter, 1021b30-1022a2, ll. b31-2 refer to (2); ll. b32-a1 to (1) while ll. a1-3 refer to things which possess the accomplishment. See Kirwan (1973:167) for a different interpretation. For the claim that excellence as perfection/completion of a thing's nature should not be identified as a qualitative change se *Phys.* 246a11-b2. (cf. Tracy (1969:159))

(1923:332) Further, for an entity, x, to achieve its natural end is for x to achieve its natural excellence.[347]

Given the evidence of *dA* II.4, achieving the end does not point here merely to a capacity, i.e. the attainment of a first–level actuality, but also to the exercising of a capacity, i.e., to a second-level actuality, in our case the activities of nutritive and reproductive capacities.[348] The good is linked with the activity of the corresponding capacity, i.e. with the second-level potentiality. This value is something that characterises both the sub-lunary and super-lunary world, whatever their exact relation turns out to be, and it is not something over and above the corresponding actualities but something constitutive of *being F* in full actuality. This offers a link between reproduction/nutrition and the good. Further, it suggests an answer to the question why the natures of living things should aim at what is better, since the generative/nutritive capacities are constitutive parts of these natures (whatever further soul-faculties these natures include).

The link between completeness and excellence, in *Met.* V.16, suggests a link between the activity of the capacities of an organism with what is better. Further, it offers a reason why living things should aim at what is better, namely the exercise of their capacities. For, surely even if we suppose as established that if living things aim at what is better they do so through the activities of nutrition and reproduction because these activities guarantee persistence, and persistence is good, it does not follow that they would aim at this good. One more premise is needed to secure this, namely a premise that will guarantee that if being an

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[347] This equivalence between completion and excellence is also suggest by the comment Aristotle makes in clarifying (2). He justifies his use of completion as achieving some excellence as: '(i) and excellence is a completion; (ii) for each thing is complete and every substance is complete, when in respect of the form of its proper excellence it lacks no part of its natural magnitude.' Point (i) may be confined to uses of *complete* coming under (2). But point (ii), which justifies (i), applies more widely. For it refers to substances, including items whose completeness may come under (1) or (3). Further, (ii) seems to do more than justifying the claim in (i) that an excellence is a completion. On one reading it is saying that every completion is an excellence.

[348] As Kirwan points the accomplishment is an *hexis* in the sense of activity and not in the sense of having a disposition. (1973:167) *Being F* points to possessing the form characteristic of *Fs* in full actuality, i.e. in such a way as to be able of exercising the functions of the capacities that constitute the nature of *Fs*.

F in actuality is more valuable than not, organisms will aim at this value. But now the nutritive and reproductive capacities, identified as a minimum of what it is to be an organism, in aiming at the corresponding activities, aim at completing or perfecting the nature of the organism. The fact that they are directed to the activities constitutive of the nature of an *F* in full actuality, means that the nature of *F* is thereby directed to the perfection that corresponds to *F* things; to the excellence appropriate to organisms falling under the kind *F*.

Let us summarise the above discussion. Natural[349] generation involves two principles, (P1), similar organisms come from similar generation processes, and (P2), similar processes of generation come from similar organisms. The reproduction of organisms possessing the fully developed form of the kind relies on specifically the same efficient causes producing this form, and specifically the same efficient causes can only come from organisms possessing the same form. The mechanism that grounds this directive agency of the form is the reproductive capacity which is part of that form. The reproductive capacity, as part of the nature of the organism aims at the corresponding exercise as the completion and perfection of that nature. The direction of this capacity to the corresponding actuality entails the permanence of those natural kinds whose form includes such a power.

4. The permanence of natural kinds

Aristotelian natural kinds, or at least those that are natural in the strong understanding of nature, persist eternally. The element that guarantees their persistence must be what grounds the teleological explanation of their generation and must be a part of their substantial nature. In the previous section it was suggested that permanence is the result of an inherent tendency of the natures of organisms to aim at fully actualised forms of natural kinds as something good. In this section I wish to consider a general division of ways in

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[349] Here nature is understood in the strong sense.

which one could argue for the eternity of animal kinds, as set out by John Cooper, and provide some evidence for one of these lines, compatible with the above suggestion.[350]

Cooper outlines three alternative ways one may wish to defend the permanence of the species. The first alternative is a materialist account according to which 'the materials of the world being what they are, and having the natures they do, the world naturally tends, by the operation of nothing but material principles, to produce and maintain just those kinds of living things that are actually observed.'[351] The second alternative is a 'Platonizing' explanation holding that 'it is a fundamental fact about nature... that it tends toward maximal richness and variety and then argues that precisely the natural kinds that are actually observed, together with the environing inorganic stuffs, constitute the maximally rich and varied world.'[352] The third option occupies a middle position between the materialist and the Platonizing explanation, and Cooper argues that this is the position Aristotle actually endorses: 'one might simply accept as a fundamental postulate of physical theory that the world permanently has whatever species it contains; that is one might hold that [a] it is an irreducible fact about the world, not further to be explained, that [b] it so governs itself as to preserve in existence the species of well-adapted living things that it actually contains.' (1987:249) However, the three positions Cooper considers may not be exhaustive, since it seems that there are more than one readings of his third alternative. They depend on whether one accepts both [a] and [b] above. In particular there are reasons for doubting [a].

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[350] The way in which the persistence of natural kinds is established depends to some extent on how questions regarding cosmic teleology are answered. I will not examine the latter issue, but in some respects that affect the line I wish to take with respect to the permanence of natural kinds.

[351] Cooper (1987:249). Cooper takes Aristotle's argument in *Physics* II.8 (198b32-199a8) as directed against such a materialist explanation.

[352] Cooper (1987:249). He offers some reasons why this line is incompatible with Aristotle's position. The main thrust of his argument is that the Platonizing position relies on some metaphysical considerations that conflict with well-established metaphysical principles.' In particular Cooper claims that this second alternative relies on the assumption that standards of richness and variety 'can be clearly conceived and specified in purely intellectual terms, in advance of study of the actual world, and that these standards can then be thought of as imposed on the world, as principles it must conform

The examination of *GA* I.1 suggested that nature, understood in the strong sense governs itself in such a way so as to preserve the existence of the species because this is the result of the tendency of natural kinds towards exercising their capacities as something valuable. If so it is not the case that the aggregate of the species of reproducing living things governs itself in a way which is further unexplainable. Further, in *GA* II.1 this tendency of the sub-lunary world is derived *anothen*. This may be a reference to the upper cosmos, the heavens, or merely to something prior, i.e. a prior postulate or a more general comprehensive premise.[353] Either way it points to the presence of something necessitating the fact explained. The context of the claim is the teleological explanation of the principles of generation, i.e. male and female:

In so far as this [why one animal comes to be formed, and is, male, and another female] occurs for the better, i.e. on account of the final cause (the Cause for the sake of which) the principle is derived from above. (II.1 731b23-5)

The way the principles of males and females are derived from that which is prior is given in the following lines which give a teleological explanation of generation, and preservation of animal kinds:

For since some existing things are eternal and divine, while the others are capable of being and not-being, and since the good and the divine is always in virtue of its own nature a cause of the better in things that are capable while the non-eternal is capable both of being <and not being>, and of partaking in both the worse and the better, and since soul is a better thing than body, and the ensouled than the soulless because of the soul, and being than not-being, and living than not living –for these reasons there is generation of animals. For since the nature of such a kind cannot be eternal, that which comes into being is eternal in the way that is possible for it. Now it is not possible in number (*for the being of existing things is in the particular, and if this were such it would be eternal*) but it is possible in form. That is why there is always a kind -of men and of animals and of plants. Since their source is the male and the female it must be for the sake of generation that male and female exist in those that have them. (*GA* II.1 731b25-732a2; Balme's tr.)

Things are divided into (a) those that admit of being and not-being and (b) those that do not, and some of the things under (b) act as causes for the better in things under (a), which are the only things that admit of better or worse. Again the link here need not be between value and

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to ... And Aristotle's metaphysics of the good rules out any such abstractly conceived standards.' (1987:249) For the differences between Platonic and Aristotelian teleology see Johansen (2004:95f.).

existence as a property but rather between value and the possession of a form in full actuality as something complete. This is suggested by the claim that soul, and what possesses soul, being and life is better than what does not. So the best for things that admit of better and worse would be to always possess soul, being and life. A result of that would be some form of persistence. Now the difficult portion of the argument comes in the parenthesis where Aristotle explains why the only possible way of persistence for things under (a) is persistence not in number but in *eidei* (in form). The parenthesis may be taken as clarifying why the particular cannot persist numerically. In that case *toiouton* in l. b35 refers to the particular thing's being eternal in number. The impossibility involved is the following: if the particular thing were eternal in number it would have been eternal *tout court*. But it cannot be eternal since it is mortal. So the antecedent, claiming eternity in number, must be rejected.[354]

Against this reading Lennox proposes a different reading of the passage. He takes *toiouton* as referring to a platonic kind of form or essence, and argues that the parenthesis considers the further impossibility that 'if the *ousia* were a such (*toiouton*), i.e. a platonic essence, the *ousia* (and not the generated thing) would be eternal.'[355] The parenthesis offers a *per impossibile* argument against the claim that eternal persistence is due to a platonic essence which is numerically eternal. This cannot be the case since being is in the particular and not in a universal, such as a platonic essence. However, Aristotle here entertains this possibility in order to show that even if this view were correct it would not make the particular eternal, but the universal platonic essence. So Lennox concludes that here

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[353] Balme's reading. (1972:155) For the former reading see Peck *ad. loc.*; Kahn (1985:194-5).

[354] See Balme (1972:156) and Peck's footnote *ad loc.*. The whole passage is standardly considered jointly with the argument from *dA* II.4 415a29-b1 discussed above. For God's immortality see *DC* II.3 286a7-12.

[355] According to Lennox the first impossibility is exploited before the parenthesis: 'Aristotle expects us to see that since the particular under consideration is a generated thing and since its being is not apart form it, it cannot be eternal in number.' Then in the parenthesis he considers the possibility that if the essence were not in the particular one could suggest that the essence was numerically eternal. See Lennox (1985:71-2)

Aristotle argues against a platonist who claims that the form is numerically eternal, and consequently against the claim that the nature of the kinds of generated things are numerically eternal.

On this reading the objectionable feature is that on the assumption considered in the *protasis* the wrong kind of thing (i.e. the platonic essence and not the particular) comes out as eternal. However, this is not what is stressed in the *apodosis*. The *apodosis* can be taken as stressing not that the *wrong kind of thing is eternal*, but rather that the right kind of thing is eternal *in the wrong kind of way*. Another reason which casts some doubt on Lennox's reading is that immediately after the parenthesis Aristotle's concludes that this is why there is always a kind of men and animals and plants.[356] The eternity of the kind could suggest that Aristotle is in agreement and not at odds with the idea that natural kind forms enjoy eternal persistence (at least in some sense).[357]

To conclude, persistence is guaranteed through the generation process of which the male and female corresponding to each kind are the principles. The division into male and female is for the sake of a generation process such that it guarantees that there will always be active individuals of the corresponding kind. This implies continuity and persistence. Therefore, the separation of the sexes depends on something prior, namely a teleological understanding of the natural world as aiming to fully actual forms of life corresponding to the various kinds.

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[356] According to Lennox *genos* in ll. a35-6 is used in the primitive sense, introduced in *Met.* V.27 1024a29-30, of a continuous generation of things with the same form. (1985:70) Even if this sense is implicit here the conclusion suggests that generation happens for the sake of persistence of the natural kinds to each of which there corresponds a male and female principle. As Cooper puts it 'it is in order to sustain these genera in existence that reproduction through sexual differentiation takes place.' (1987:247)

[357] The way in which forms exist, and in what sense divisibility applies to them are questions that cannot be settled by the evidence of the biological passages alone. They require the study of the related passages from the *Metaphysics*. However, here is a final though more speculative reason against Lennox's argument. Eternal persistence is introduced here as what explains teleologically separation of sexes in animal generation. Whatever element persists must be such that *it* confers some value to the operation or to the instruments that are for the sake of it. If what persists is the natural kind form it is the value of its persistence. Therefore, its persistence cannot just be a side effect of the

In the above argument from *GA* II.1 the division into male and female is for the sake of generation. Generation in its turn happens for the sake of preservation of the kind and for the sake of the form of life characteristic of this kind. Finally the latter are justified by the idea that being an *F* (in full actuality) is better than not. It is difficult to say where exactly the priority lies here, and depending on where the priority lies there are at least three possible readings for the Aristotelian position that Cooper distinguishes from its materialist and platonistic counterparts.

Cooper's line, or at least one way of understanding his proposal, is that preservation of kinds is a basic fact of the physical world, and therefore, whatever conforms to this principle or promotes it, is good. This is a principle Aristotle assumes.[358] According to Cooper's account forms of natural kinds are goals in nature. Whatever promotes their persistence is valuable. Reproduction of each kind through copulation promotes persistence of the form. Therefore reproduction through copulation is something individuals under each natural kind are aiming at. So the eternal persistence of the species is something basic and therefore valuable and reproduction is valuable because it promotes it. This is where explanation stops.

The second alternative consists in taking the opposite line, namely that kinds, or their forms, aim at persistence because this is something valuable. The reason why it may be thought of as being something valuable is that this is the mode of existence of the divine.[359] The good and divine character of eternal existence is something basic and this is what drives the natures of living things in aiming at achieving some form of persistence. Through

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fact that living things produce something only similar to themselves, i.e. they fail to produce something identical to themselves.

[358] According to Cooper this principle of natural teleology is what explains that matter is always or for the most part organised into the specific structures of natural living things. In his 1982 paper he writes: 'there is inherent in the world a fundamental tendency to preserve permanently the species of living things it contains... This tendency, which is not ultimately reducible to the powers and properties of matter-kinds, is irreducibly teleological.' (1982:213-4)

[359] To draw the conclusion concerning the preservation of natural kinds one more premise is needed to the effect that the natural world is inherently good. Although no such premise is explicit in

persistence the sub-lunary natures are partaking of the divine, i.e. they partake of a divine attribute. Whatever exists by nature aims at eternity, or whatever form of eternal existence is possible for it. So, given that something exists its persistence is something its nature aims towards because it is good. The persistence of natural kinds through reproduction is a manifestation of this basic value in the natural world.[360] But this existential reading is problematic in at least two respects. First, why should existence be thought of as something valuable in itself? As we saw in the previous section this existential reading of the claim that being is better than not-being does not conform with the claim that being or existence is not an item that falls under any one of the categories. And if existence is not a property how can it be thought of as something good, let alone the good on which generation in the natural world is grounded? Further, even if existence is something good why is it that spontaneously generated things do not aim at maximising their existence by persisting in the manner sexually generated animals do? For if existence is something good, then even if their reproduction implies an infinite series of different forms, it is better for this series to exist.

This last objection may suggest a third alternative. As we saw in *GA* I.1 the persistence of sexually generated kinds accords with two principles that guarantee constancy in the natural world. This is what is distinctive about these kinds. The two principles guarantee that the changes involved in the generation processes corresponding to them do not alter the natural world in significant respects. Instead they guarantee regularity,

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the *GA* argument, it may be implicit in passages where nature is said to act always for the better. (*IA* II.704b14-7)

[360] The difference then with Cooper's line is the following: what is good and a goal in the natural world is eternal existence, i.e. persistence. Reproduction entails the persistence of the element that gets reproduced. What is reproduced through copulation is the form of the natural kind. Therefore forms of natural kinds are the goals of generation processes in the animal world. This second line is perhaps closest to the Platonizing account presented by Cooper. Yet it differs from it in that it makes no claim concerning richness and variation in the natural world. The suggestion then is that this aim is simply an aim to maximise life and existence. At least one commentator finds this claim in the *GA* II.1 as the heart of Aristotle's teleology: 'the universe is as it is because it thus maximizes existence, soul and mind. This is a faith, if you like a religious faith, but it is not simply an acceptance of popular

continuity and stability in it. In that respect the sub-lunary world is very similar at least at the level of natural kinds to the unchanging and eternal character of the super-lunary world. On the other hand, in *dA* II.4, the generative/nutritive capacity of living things as what is distinctive about them, aims at the corresponding activities of generation and nutrition. The things that possess this capacity in themselves aim at the corresponding activities as something that completes and perfects their nature, for this completion is the excellence belonging to their nature.[361] The result of the exercise of the nutritive capacity is the persistence of individuals that possess the form of the kind in full actuality. Again this is linked, in *dA* II.4, with the divine entities of the super-lunary world. The link between the two kinds of entities must be based on the completeness and excellence entailed by the exercising of the activity, i.e., this is a value characterising both super-lunary and sub-lunary world. The suggestion then is that persistence is a result of the tendency of living entities in the natural world to exercise their natural capacities because this aims at the completion and perfection of the things that possess these natural capacities.

The difference between Cooper's line and this latter suggestion is perhaps only one of emphasis. According to Cooper's line natural generation and persistence of natural kinds is due to the existence of the forms of those kinds as goals, and there is no further explanation why their forms are aimed at. On the alternative line generation is due to a general tendency permeating the natures in the Aristotelian universe for activity as the mark of completeness and perfection.

Independently of this difference, the two readings are subject to two kinds of objections. The first one comes from an interpretative line that argues for the persistence of natural kinds through the activity of some element other than the form of the kind, e.g. vital heat or *sumphuton pneuma*. There are a number of variants of this line, but what is common

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superstition or an unquestioned assimilation to the religious tradition. It is the cornerstone of the possibility of thinking about the world in an Aristotelian way.' [Preus (1990: 490)]

[361] *GC* II.6 333b17-20.

between them is that they subscribe to the sufficiency of material causes.[362] The most recent and fullest account is offered by Freudenthal's account of vital heat as necessitating the persistence of natural kinds. The element of vital heat has the sufficient powers (formal and efficient) for generation, growth and reproduction in the natural world. Examining this proposal amounts in turning from the consideration of the thesis concerning the permanence of natural kinds to a consideration of the thesis of the Sufficiency of Material Causes and an investigation of the nature of efficient cause in the generation of animals.

Another source of objections to the above line comes from Gotthelf's interpretation of the good in Aristotle's teleology. According to this interpretation ends are not based on the notion of good. In some sense any reference to the good is reducible to something primary or more basic, namely the notion of an end or the notion of actuality. So reference to the good is secondary or derivative.[363] However, Gotthelf does not argue for the stronger position that there are ends or actualities which are independent from normative claims, but only for the weaker thesis concerning the priority between the two. Indeed he says that normative language remains a valuable heuristic for 'finding out what end a part or process has... [by] ask[ing] what good it serves, what benefit it provides.' (1987b:134) To the extent that this discussion regards the priority relations between good and actuality it requires a close examination of the relating passages, not only in the biological works, but also in the *Metaphysics* and the *Nichomachean Ethics*. This would require a deviation from our main line of inquiry concerning the way teleological explanation of the generation and function of living things determines what they are. I will not examine the contrast between Gotthelf's

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[362] I classify as reductionist here what comes under (I) limited reducibility, (II) weak reducibility and (III) anti-eliminativism, in Gotthelf's classification (1997). Freudenthal exemplifies the position of weak irreducibility. He argues that 'what informs matter so as to perpetuate the species is precisely vital heat.'(1995:37) Other representatives of the reductionist view are Bradie & Miller (1984/1999); Lewis (1988).

[363] Gotthelf argues for this interpretation by defending two basic claims. First, goodness of a property *p* in biological contexts is regularly *p*'s capacity to contribute to the continued life of the organism which has or performs or undergoes *p*. ,This is equivalent to the formula: the goodness of A is A's capacity to contribute to the persistence of B where B has A. The second claim is that the

interpretation and the one outlined in the previous sections. Instead I will turn to the reductionist interpretations which are opposed both to Gotthelf's interpretation and the interpretation outlined above.

5. Conclusion

Let us conclude with some points the above analysis of generation and nutrition suggests with respect to the essence of living things. First, the nutritive/generative faculty as a defining feature of living things as such is an essential feature of them defined at the generic level. The arguments considered above, aiming at proving the explanatory basic role of nutritive and generative capacities for living things are conducted at the most generic level. Some at the level of a common generic nature between the genus of plants and that of animals while others at the level of these genera taken separately.[364] Features belonging to the essence of the kind may come at different levels of generality, and they could jointly constrain and determine other necessary properties belonging to the kind. But this point needs to be put cautiously. First, nutritive soul does not stand to the other parts of the soul as a genus stands to more specific and determined forms inside that genus. Secondly the *de An.* II.1-3 account of the definition of soul concludes that soul must be defined at the level of specific kinds of living things, not at a generic level, e.g. the level of the kind living thing.

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notion of what it is to live, or what it is to persist, does not itself rest on a prior notion of the good. (cf. Gotthelf (1987b: 117))

[364] This observation accords with the thesis proposed by Charles that in the biological works Aristotle does not hold that there is a single basic explanatory feature which could be identified as the essence of living things. (2000:339-40). According to Charles the *Analytics* argument poses exactly such a constraint which is then abandoned or relaxed in the biological works. The tight *Analytics* conception of *common nature* is replaced by an understanding of common natures as *interactive unities*: 'In this account, the unity of a kind will consist (partly) in the interaction of its explanatory features (whether formal or material) to determine some of its derived features... The resulting unity might be termed an *interactive unity*, because it rests on the distinctive interconnection of several causal features, and not on the presence of one common cause or starting point.' But first it is not evident that this is the only way to read the thesis argued for in the *Analytics*. The common nature of a kind may comprise essential features at different levels of generality (some of them common to it and other co-generic kinds). If so the explanatory work attributed to the essence of a kind may be due to the interaction between these different features.

Secondly, the definition of the common generic nature of living things in terms of their nutritive/generative capacities is what implants teleology into the essences or forms of natural kinds. Natural kinds of living things are, *qua* living things, teleologically functioning systems. The teleological behavior of organisms follows from the fact that their nutritive/generative capacities aim at what constitutes a state of completeness and excellence, i.e. the excellence appropriate to life. The exercise of this capacity gives rise to two different kinds of teleological explanations. The explanation of generation in terms of what it aims at (re)producing and the explanation of animal parts in terms of their functions.

Finally, the introductory arguments concerning generation processes in *GA* I. and II give evidence that the efficient cause enters into the determining essential features of a natural kind. It is the form's activity, rather than some material substance to whose activity the former is reducible, that directs the development of the generated organism. In the following chapter I turn to the examination of this last point.

1. Introduction

Aristotelian natural kinds persist eternally whether the value of their persistence is (a) something irreducibly good, or (b) reducible to and derivable from something more basic, e.g. Gotthelf's irreducible potential for form. However, we saw that there is a third alternative concerning the persistence of natural kinds according to which persistence does not consist, ultimately, in some irreducible potential for form. What is designated by the expression 'potential for form' is reducible to a different element or substance responsible for the generation and maintenance of an organism. Thus generation can be sufficiently explained by appealing to this element, i.e. there is a causal chain such that it does not involve the form of natural kind, *K*, which sufficiently explains the generation of living things under *K*. This thesis is independent of two stronger ones. First, that reducibility here entails elimination. Second that the level of this irreducible potential is the level of the four basic elements. The latter claim would entail some form of materialism similar to the one considered by Cooper (see ch. 6). None of the accounts considered here leans towards the stronger claims. They hold only the weaker thesis that the activity necessitating generation processes is reducible to the activity of an element other than the four basic ones, sc. vital heat. In what follows I will argue that the potential for form, or the activity of form, is not reducible to the activity of a lower level element such as vital heat, that causes of a material nature are not sufficient for generating living things, and that instead the form is actively involved as an efficient cause in generation.

2. Persistence of natural kinds in terms of vital heat

Freudenthal's account of the permanence of natural kinds and of the persistence of individual living things in terms of vital heat constitutes a paradigmatic example of the line of interpretation that reduces the potential for form to some more basic substance in the natural world, and provides the fullest defense for such a line. This line is in contrast both with

materialist accounts from below and platonizing accounts from above, but also with accounts that refer to a non-reducible element that sanctions teleological explanation such as Gotthelf's irreducible potential for form or Cooper's forms of living things as natural goals.[365] Instead persistence of natural kinds is due to the operation of the semi-divine element of vital heat. The controversy is whether Aristotle's account of generation is reducible to one form-free causal chain which necessitates the generation of the offspring or not. Or more generally whether Aristotle's account is reducible to his physics. Freudenthal, however, dismisses the latter formulation, by arguing that this controversy arises from an ambiguity in what is meant by 'physical':[366]

> If vital heat, including its formative capacities, is reckoned to be a 'physical' power, then Aristotle obviously upholds physical *necessitation* 'from below' and reductionism in the sense that all that is required to inform suitable matter into homeomerous or living substances –namely the efficient cause (the warmth) and the form (the 'program')- is 'in' the substance carrying the vital heat (blood, semen, putrefying matter, rennet, etc.). In fact, when, say, the vital heat in semen acts on suitable female matter, an offspring usually results by necessity. If, by contrast, we choose to use the term 'physical' in the more customary sense, namely as referring only to those capacities which matter has in virtue of the natural necessities appertaining to the four elements or elementary powers, then, of course, there is not physical necessitation from below, and the form must be considered as coming in from elsewhere, namely from the non-'physical', formative component of vital heat, i.e. soul.

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[365] A similar position is proposed by Bradie & Miller (1984/1999:133-146/76-89). Bradie & Miller distinguish between the materialist thesis Aristotle rejects, namely, (I), that the potential for form is reducible to the potential of the simple elements, and the more limited one he endorses, namely that, (II) the potential for form is reducible to something, at some level of explanation. This move allows to interpret Aristotelian teleology as involving two theses: (T1) in a life process, the goal is produced by means of a potential existing from the outset, through movement conforming to a formal principle; (T2) the source of the movement through which life processes occur is vital heat. (1999: 86) While (T2) has been falsified by modern science (T1) which is the core teleological thesis is still credible. Two things follow. First, for Bradie and Miller, the only difference between Aristotelian and modern science has to do with the element to which the type of movement is attributed, vital heat and DNA respectively. Secondly, Aristotle's (T1) leaves room for an explanation in terms of the movements of DNA molecules. (1999:85)

Similarly Freudenthal argues that what constitutes the basis for rejecting a materialist account, does not entail that a reductivist account in terms of vital heat is not possible. (1995:45). On the other hand Freudenthal attacks Cooper's line by claiming that 'the *phusis* of each species (on which depends its eternity) is within each and every (male) individual of that species [in terms of vital heat] and not in the realm of transcendental Forms.' (1995:38) That is he takes Cooper's account to suggest such a platonic conception of *phusis* which is what Aristotle's dictum, i.e. that man generates man, is directed against. Finally, Tracy emphasizes the role of vital heat for the generation and persistence of organisms, but this may be a consequence of his concentrating on the analysis of material processes in the animal's life. For he does not attribute formal powers to vital heat which he distinguishes from the role of formal nature or essence. (1969:162, 169)

[366] Freudenthal (1995:34).

I think, however, that the dilemma is not just one of terminology, trading on the ambiguity of 'physical'. Everyone seems to agree that Aristotle's account is not physicalistic in the sense of being reducible to the activity of the basic elements.[367] But not everyone agrees that the account is physicalistic in the second sense. The disagreement is over whether there is physical necessitation from below, in the sense that the substance carrying the vital heat has the warmth and the 'program',[368] and thus all that is required for generation. Some argue for such a necessitation from below, while others argue for its insufficiency, and the dilemma is real if the two positions cannot both be true. I will support the claim that both positions cannot be true by arguing against the claim that the formative power is reducible to warmth plus the 'program' (which equals vital heat). I will argue that Aristotle's account is not reductionist in this sense (nor *a fortiori* in the stronger sense).

There are at least two problems with the reductionist account. First vital heat is considered to be an instrument at the disposition of the nature of a living thing, where this is understood as the substantial nature or form.[369] Thus nature plays an active role in generation processes by using vital heat and not by being an integral part of that heat. Further, if vital heat is used by the form for the generation of organisms it is not the case that there is a causal chain which is persistently form-free and can sufficiently account for that generation. The second worry relates to the question how well a reductionist account fares with respect to cases of spontaneous generation. Spontaneous generation displays some similarities and some crucial asymmetries to generation by copulation. Is an account of

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[367] So, for instance, Broadie [Waterlow] (1982:152-158); Lewis (1988); Gotthelf (1997). It is not accurate that there is universal agreement. The line developed by Wieland, and followed by Nussbaum and Sorabji, is taken as claiming that material efficient causes are sufficient in explaining the formation and functioning of living things. Their views are classified by Gotthelf under the heading Pragmatic view (see *Introduction* and Gotthelf (1997c:76)).

[368] The program metaphor is used by Freudenthal (1995:28) who follows Cooper (1990). (cf. Furth (1985:118).

[369] One of the passages that support the view that vital heat is an instrument is *dA* II.4 416a13, where Aristotle says that vital heat is a co-cause, while soul is the ultimate cause which uses vital heat as an instrument. See also Verbeke (1978:195). For the claim that *pneuma* is instrumental in sensation see *PA* II.10 656b16 (See also *De Sensu* 439a1 ff).

generation and persistence in terms of vital heat capable of accounting for the differences and similarities between the two cases? By examining the first worry in §4 it will emerge a clearer picture of the nature of efficient causes in generation and of their relation to final/formal causes.[370] But first let us consider Freudenthal's proposal concerning the two levels of explanation.

3. Generation and the two levels of explanation hypothesis

Aristotle's account of generation in the *GA*, focuses primarily in cases of sexual reproduction. The offspring is constituted out of the material contribution by the female and the principle of change contributed by the male through his semen. The two contributions possess the corresponding passive and active *dunameis* for producing an organism (once the two powers come together in the appropriate way). The male's contribution is responsible for the transmission of form and therefore the *dunamis* residing in its semen is somehow responsible for the transmission of the soul-faculties, i.e. of form, to the foetus.

The presence of this potential for form in the male's semen is cashed out in terms of specific movements.[371] There are two aspects of these movements that motivate the reductionist account. First, that which allows the subsistence of the movement in the semen is the *pneuma* contained in it (a kind of hot and wet air) or more accurately the vital heat persisting in the *pneuma*. Second, in some occasions Aristotle refers to the movement in the semen as conforming to a formal principle (*logos*). It possesses a principle such that it can produce an offspring of the same kind as its generating parents. This *logos* is present in the semen through subsisting in the heat contained in it, which suggests a link between formal properties and the relevant heat. These two points lead some commentators to ascribe the formal principle subsisting in the movement to the vital heat present in the *pneuma*, and to argue that the latter is the source of the former. Thus vital heat is the principle accounting

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[370] For the question arising from spontaneous generation see *Appendix III*.
[371] II.4 740b26-36; cf. Bradie and Miller (1999:80).

for the generation of living things and its *dunamis* is the potential to which the potential for form is reducible. As a result, formal properties such as being inherently proportional, self-limiting and directive are ascribed to vital heat. Alternatively, the activity of the heat could be identified with the activity of the more basic soul-faculty, namely nutritive soul.[372] According to Freudenthal vital heat is an informing power: 'vital heat is heat charged with specific, formative movements, which are precisely what makes it into soul-heat.' (1995:29) He identifies vital heat with nutritive soul. Thus it is vital that uses the heat as an instrument and thus offers a material basis to which the potential for form can be reduced.

The general reductionist line faces the following difficulty. Fire is a concurrent cause of nutrition and growth in *dA* II.4 416a9-15. If fire here does refer to vital heat's role, contrary to what the reductionist claims, then vital heat is not offering the whole of the causal story of nutrition and growth. Secondly, in the *GA* heat is an instrument used by the soul. (II.4 740b30) Again it is not clear that this heat is different from vital heat, as the reductionist interpretation would take it. So if this claim refers to the activity of vital heat, then vital heat is not sufficient to regulate generation and produce the desired result. Freudenthal's suggestion resists this pressure by the hypothesis of a double explanatory level. In explanations where heat or fire is referred to as only an efficient cause, the heat is equivalent to the element fire and therefore is not proper vital heat. This kind of heat is merely a contributory cause and an instrument. In the second set of explanations we have a

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[372] Freudenthal argues for the self-limiting character of vital heat and the proportionality inherent in it (1995:32-33). For all three aspects see Bradie & Miller. They argue that 'the source of this movement, through which reproduction and growth occur, is vital heat, which cannot be identified with the potentials of the simple sublunary elements.' (1999:81) Presumably the potential for form is reducible to, if not identical with, this potential, since they claim that the movements required for reproduction and growth are maintained and regulated by the principle of vital heat. Freudenthal also claims that vital heat is an informing power: 'vital heat is heat charged with specific, formative movements, which are precisely what makes it into soul-heat.' (1995:29) The activity of nutritive soul is thus closely associated, if not identical to, the activity of vital heat. Concerning the relation between nutritive soul and vital heat he writes: 'How does the physiological account in terms of vital heat qua informing power relate to the psychological one in terms of nutritive soul? it would seem that where both accounts are applicable Aristotle holds an identity theory: Aristotle's physiological theory assigns to the vital heat the role of producing the forms of homoeomerous parts, a role which the

description of the function of proper *vital heat*. It is this latter kind of heat that includes formal as well as efficient powers and sufficiently explains generation and growth. The two explanatory levels are equivalent and therefore interchangeable.[373] Freudenthal finds the two kinds of explanations outlined above in two passages dealing with structural growth. The first comes from the *GA* and refers to vital heat. The second one comes from *dA* II.4 and claims that fire is not, unqualifiedly, the cause of growth but only a contributory cause, and refers to simple heat:

> This heat resides in the seminal residue, and the movement and the activity which it possesses are in amount and character correctly proportioned to suit each several parts. If they are at all deficient or excessive, to that extent they cause the forming product to be inferior or deformed. The same is true of things that are ''set'' by heat elsewhere than in the uterus: e.g. things which we boil to make them pleasant for food, or for any other practical purpose, the only difference is that in this case the correct proportion of heat to suit the movement is supplied by us, whereas in the other, it is supplied by the nature of the generating parent (II.6 743a27-35; Peck's tr.)[374]

> ...it is not absolutely a cause which is much more properly the soul; for the growth of fire is without limit, so long as there is something to be burned, but of all things naturally composed there is limit or proposition of size and growth (*dA* II.4 416a15-8)

Freudenthal takes it that the two passages deal with the same entity viewed from two different perspectives. The *GA* passage deals directly with vital heat. It affirms that vital heat is both an efficient and a formal cause. The *dA* passage on the other hand does not deal with vital heat, but just with the element fire. Heat, viewed in this way, has only a secondary role, i.e. that of being the efficient cause, while the role of the formal cause is attributed to the soul. The soul uses heat as an instrument for the growth of the organism. However, soul does not use *vital heat* as an instrument. To say that soul uses vital heat as an instrument

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psychological theory attributes to the working of nutritive soul.' (1995:30) This hypothesis of two levels of explanation is discussed below.

[373] 'One may draw on the notion of vital heat as at once an efficient and a formal cause; or one may attend to its warming effect only, abstracting away from the informing capacity of the movements inhering in the vital heat, which must then be ascribed to a distinct 'formal' entity (namely soul).' (1995:31) Elsewhere he writes: 'The two accounts are obviously equivalent: the operations of vital heat as construed in the *Generation of Animals* are by their very nature constrained by 'limit and ratio', precisely the distinctive marks of processes governed by soul according to the *De Anima*. The use of one theoretical vocabulary rather than the other depends on the context.' (1995:33)

[374] See also I.18 723a29; I.19 727b12; IV.2 767a17 ff. for the *summetria* between male and female contribution in generation.

would be redundant.[375] So what distinguishes mere heat, or fire, from vital heat is that the latter carries forms supplied by the nature of the generating parent. By forms we should understand a certain *logos* or proportion.

However, this proportion is not intrinsic to the heat, but rather determined by the nature of the parent. The heat exists in the semen and by means of concoction the nature of the generating parent supplies the right proportion to the heat so that it will be suitable for the change, i.e. it will be *vital* heat. That the heat does not necessarily come with the right proportion or *logos* is confirmed by the claim that the proportion might be deficient or excessive, and thus cause the forming product to be inferior or deformed. (II.6 743a29-31) And if this is so the right proportion is ultimately dependent on some factor, such as the form of the generating parent, supplying it. To that extent vital heat is an instrument. In the case of artifacts it is an instrument in the hands of the craftsman, while in the case of generation it is an instrument of the nature of the generating parent. The *GA* passage quoted above continues thus:

> heat and cooling (which is deprivation of heat) are both employed by nature. Each has the faculty, grounded in necessity, of making one thing into this and another thing into that; but in the case of the forming of the embryo it is for a purpose that their power of heating and cooling is exerted and that each part is formed... (II.6 743a36-743b5; Peck's tr.)

This passage is difficult to reconcile with the hypothesis of two explanatory levels suggested by Freudenthal. One could argue that when Aristotle talks about heat in this latter passage he is slipping into the vocabulary of the *dA* framework. But the supposition of such a sudden change of language is hardly convincing. Further, the hypothesis is that the two explanatory levels, physiological and psychological, exemplified correspondingly by the passages in *GA* and *dA*, depend on the context, i.e. on whether the context is biological or psychological. This difference in context is supposed to explain the different picture in the *dA* and *GA* passages. On that assumption it is strange that Aristotle falls back into the terminology of

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[375] In Freudenthal's words this would be 'an incorrect usage of mixed language, for vital heat already carries forms.' (1995:33)

the psychological framework in the middle of a biological passage where he is supposedly introducing the idea that vital heat is equivalent to nutritive soul. This rather suggests that there is no inconsistency between the two passages because in both places the heat in question is instrumental, used by the factor that supplies the appropriate proportion or *logos*, i.e. the nature of the generating parent. Hence there is some reason to doubt the hypothesis of two explanatory levels and the resulting identification of vital heat with nutritive soul.

If this is correct and vital heat is divorced from any formal characteristics then it cannot be sufficient for explaining how the movements required for reproduction and generation are maintained and regulated. Thus it cannot explain the persistence of natural kinds. Some other explanatory factor must be invoked. In the following section I examine the account of generation as evidence against the reduction of the potential for form to vital heat, and I will try to meet the claims that vital heat is inherently proportional, self-limiting and directive, supporting this reduction. I will argue that the form of the kind is what regulates and directs the process and thus explains the persistence of the kind.

4. Vital heat, necessitation and the account of generation

Let us look at the details of the *GA* II account motivating the reductionist claims.[376] In *GA* II.1 Aristotle suggests a classification of animal kinds by reference to the quality of the heat they possess.[377] Sanguineous animals are prior in that respect and thus the discussion of the role of efficient causes in generation, starts from the examination of sanguineous, copulating, hotter and semen emitting animals.

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[376] The account of spontaneous generation from *GA* III is also taken as evidence for the vital heat account. It is discussed in *Appendix III*.

[377] At 732b30 viviparous animals are distinguished as being more perfect because they partake of a purer principle: the more perfect animals are those which are by their nature hotter and more fluid and are not earthy. The hot and the moist are said to be of a more perfect nature as opposed to the dry and the cold. (733a10-11) This discussion culminates with the claim that there is an ordered gradation of generation processes of natural kinds. As a result animal kinds are ranked into five classes depending on how hot they are and at what stage of perfection they produce their young.

4.1. Is that which shapes internal or external?

The inquiry into efficient causation in *GA* II addresses the two following issues. First, (I), either (a) animals are fashioned by something external to the semen or, (b), by something internal to it. Second, (II) this forming element must either be part of the soul or be soul or possess soul. Aristotle considers difficulties involved both in (Ia) and (Ib) thus blocking both horns of the dilemma and leading to puzzlement. (II.1 734a1-734b4) The resolution consists in qualifying the two statements. The internal/external distinction can be understood in two ways. So there are two senses in which something is formed by something external only one of which points to an impossibility:

> Maybe there is some statement of ours, made without qualification, which ought to be qualified: e.g. if we ask, in what sense exactly is it impossible for the parts to be formed by something external? We see that in one sense it is possible, though in another it is not. Now it makes no difference whether (a) we say the ''semen'' or (b) that from which the semen comes, in so far as the semen has within itself the movement which the generator set going. And it is possible that A should move B, and B move C, and that the process should be like that of the 'miraculous' automatic puppets: the parts of these automatons, even while at rest, have in them somehow or other a potentiality, and when some external agency sets the first part in movement, then immediately the adjacent part comes to be in actuality. The cases then are parallel: just as with the automaton (1) in one way it is external agency which is causing the thing's movement- viz. not by being in contact with it anywhere now, but by having at one time been in contact with it, so too that from which the semen originally came, or that which fashioned the semen, <causes the embryo's movement> [i.e. development] – viz., not by being in contact with it at some point; (2) in another way, it is movement resident within <which causes it to move>, just as the activity of building causes the house to get built. (II.1 734b5-17; Peck's tr.)

(1) explains the sense in which the movement that forms the embryo can be external, while (2) explains the sense in which it cannot and thus it must be internal. The parts are formed by something external, the generating parent, who produces the movement in the semen.[378] The semen transmits this movement to the offspring and from then on the movement belongs to the offspring primarily and in itself; not on account of some other entity. So, there is no difference between (Ia) and (Ib) as far as both factors have in themselves the appropriate

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[378] The movement ultimately resides in this part of the male whence the semen is secreted, 'the region around the diaphragm in all those animals which have one, because the first principle of any natural creature's system is the heart or its counterpart while the lower parts are an appendage added for the sake of that.' (*GA* II.4 738a16-19) See also II.7 747a19-23.

movement. But how can they have the same movement? At this point the *automaton* illustration and the potentiality-actuality distinction are introduced. Before turning to them it is worth noting that if vital heat residing in the semen is the bearer of the form, instead of being an instrument 'carrying' the formal characteristics by way of its movements, one expects it to be introduced in order to tackle the puzzle. Still there is no mention of vital heat here.[379]

Instead we get the *automaton* metaphor. The parts of an *automaton*, p_1, p_2... p_n even when actually unmoved have a potentiality to do so. So when something moves p_1, the movement is transmitted to p_2,... p_n by means of p_1. But what is the analogue of p_1 in the organic case? The semen, its movement or the first part to be formed, the heart? Given the options in l. b8, (a) and (b) above, it must be the semen or its movement. Now, since *p1* is the first part moved, its analogue cannot be a movement. So it must be the semen. But against this option this element is, at the end of the passage, likened to the activity of building. Further the passage concludes that that which fashions (*poiei*) is internal to the semen. Hence it cannot be the semen, except in a loose sense where a thing can be identified with something included in it. So perhaps *p1* must be identified with the first part to be formed, e.g. the heart. Then the analogue of the external movement in the automaton case, will be the movement of the semen. The difference is that this movement in natural generation becomes a resident within what it moves, whereas in the automaton case it is always something external.

At any rate, although the analogy with the *automaton* is far from clear, the following lines give some indication against the reductionist interpretation. Aristotle says that that which is analogous to the activity of building is an agent 'not by way of being a definite thing (*tode ti*) nor is it present in the semen as something already perfected to begin with.'

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[379] Vital heat enters the scene later on at II.2 735b34, where it is claimed that semen is composed out of water and *pneuma* (i.e. hot air, air itself being hot and moist). The heat in *pneuma* is due to the internal heat of the animal. (II.2 735b34-5) This heat is identified as vital heat.

(II.1 734b18-19) So even if generative or vital heat is responsible for moving the material, this does not guarantee that it possesses a formal element. For it is not a *tode ti*, i.e. it is deprived from the determinate characteristics that whatever possesses a substantial form, or a formal element, in some stage of actuality, would normally possess. The non-*tode-ti*-ness of the movement in question may also mean that because it is a movement it is not an item under the category of substance, and thus not a *tode ti*.[380] This leads to the question concerning the application of the potentiality/actuality distinction. What is the difference between the way the potentiality/actuality pair belongs to the movement of generative heat and to the living body?

The metaphor with the activity of building introduces the same illustration as the one used in the definition of *kinesis* (change or process) in *Phys.* III.1: change is the actuality of what is potentially as such.[381] (201a10-11) The reference to actuality in the *definiens* aims at establishing the reality of change. But this should not obscure the distinction between (a) the actuality of the change, the activity of building, and (b) the actuality of that to which the change is leading, the house. (a) is incomplete in the sense that as soon as it is complete it ceases, while (b) is complete in the sense that it is not directed towards, and defined by reference to, an actuality different from it.[382] Similarly the movements of vital heat are incomplete actualities since they are directed to the setting of the embryo and as soon as this

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[380] See *Phys.* III.1 200b26 ff. For the claim that *kineseis* as defined in *Phys.* III.1 are classified under the category of relation see Broadie (1982:110-111). Michael of Ephesus' explanation is that the movement, the power in the semen, being without a body (*asomatos*), does not possess the parts in actuality as the father does, but only in potentiality and it has only their *logos* in actuality. (*In Gen. Anim.* 78 1-4).

[381] A proper analysis of the notion of change (*kinesis*) in other works and especially *Physics* III would require much more space and detailed examination than I will devote to it here. The claims made in this section rely on at least one possible reading suggested by Broadie (1982:93ff.) and followed by Johnasen (1998: 256-9).

[382] For incomplete actualities see *Phys.* III.1 201b31 ff.. For the distinction, between process-actualities and end-actualities see Broadie (1982:117-8). What is distinctive of end-actualities is that in their case 'we give none about the basis or ground of its being what it is by saying what it is not.' In the case of process actualities we give an account of what they are by referring to the state they are aiming at as something that they themselves are different from.

happens they cease. The ensouled body on the other hand, as soon as the catamenia are set, is a complete actuality.[383]

This suggests that generative heat does not include formal characteristics. It is only capable of carrying the movements that will set the embryo and transmit the movement that will reproduce the form of the kind in the offspring. But perhaps nothing more determinate can be said of it. Indeed, if vital heat had efficient as well as formal powers then it could go on producing the parts of the animal by itself throughout development, until all the parts are fully formed and development is complete. But if it was sufficient for generating the parts of an organism Aristotle would not have attributed to some of the organism's formal parts a generative role. (*GA* II.6 742a24-6) Yet this is Aristotle's favored explanation, exemplified in his account of the formation of the heart in sanguineous animals. The heart is the first organ to be formed, the principle resides in it, and it is responsible for the formation of subsequent parts.[384] In general the temporally earlier parts in the order of formation direct and control the development of the later ones. So what has the appropriate degree of determinate-ness is the form of the generating parent and the formal parts of the offspring. The latter parts control the transmission of movement by means of heat for the formation of the parts that come next in generation.

The potentiality-actuality pair of the semen may be the object of Aristotle's next remark: in nature as in art that which is formed, say a man, is formed by something which is [a man] in actuality *out of* something which is *dunamei* [a man]. (734b21-2) Although generally *out of* is taken to refer to the material, here it may refer to the generating

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[383] But what about the activity of the parts of the living body? On the one hand since they are processes they must be process actualities. On the other, since their end or completion lies in themselves *qua* functioning-moving organs, i.e. at the emergence of a further state, they seem to have some completeness or autonomy which contrasts them to the movement of the semen.

[384] See *GA* II.2 735a16-17; II.6 742b1-5. The first principle exists only in potentiality before the setting of the fetation. (740a1-8)

movement.[385] For, first, the discussion is not over problems concerning the *dunamis* of the material. Secondly, the following lines at b24-5 deal not with that *out of which* as matter, but with semen and the movement and the principle *out of* which the setting happens. The movement is such that as it ceases each of the parts is produced having soul, i.e. it has such a *dunamis*. But now this *dunamis* belongs to the semen as active. The semen's activity is a potentiality for the actuality that constitutes the setting of the fetation and the movement of its parts. Therefore, this power the activity considered as an activity/actuality must be a different or lower one than that of the ensouled organism. In that case the comment in b21-22 can be read as saying that something is made to be a man by something which is actually a man, acting externally, through the activity of something having the lower level potentiality or power to transmit the movement of growth which is itself a higher level of potentiality for further activities.

Let us turn to the claim that as the movement ceases each of the parts is formed (b24-5). The statement is ambiguous between meaning that each of the parts acquires soul, as Peck translates, or that each part is formed as an ensouled part. If each part acquires soul then it may be that the soul *qua* soul in actuality was residing somewhere else, i.e. in the movement, before it was acquired by the part. If each part is formed as ensouled then the soul as first actuality of the body is entering the scene simultaneously with the formation of each part. There was no first actuality equivalent to the first actuality of the ensouled part

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[385] In *GA* I.18 724a18 ff. the different senses of *ex hou* (out of) are discussed in order to clarify the way in which the young can be said to be out of the semen. The two relevant uses with respect to *sperma* (semen) are (1) the that from which in the sense of matter, and (2) the that from which in the sense of the principle of change. The argument of *GA* II.3 makes evident that it is the second sense which is applicable to semen. However, both options are kept open at *GA* I.19 where the semen is said to be potentially what each of the parts of the organism is actually: 'whether in respect of its own proper bulk [i.e. as matter], or because it has some *dunamis* within itself [i.e. as an *arche*].' (I.19 726b17-9; b19-24) The adverb explaining this non-actual being of the parts in the semen is *adioristos*. (I.19 726b17)

previous to the setting. Again the claim that what forms the young is not a *tode ti* favors this latter possibility.[386]

Aristotle's second question is whether semen has soul. It is thought that Aristotle's affirmative answer corroborates the view that *pneumatic* heat possesses the relevant soul, i.e. formal properties, and hence the potentiality for form is reduced to the potentiality in the generative heat. His answer refers to the homonymy principle:[387] (I) there can be no soul in anything except in that of which it is in fact the soul, and (II) nor can there be a part unless it has some soul... Clearly it does (cII) have soul and (cI) is soul -potentially. (II.1 735a6-8) The argument is compressed but here is a possible way to understand it. If semen is soul, then by (I) it must be the soul of something. Now it cannot be the soul of the young, at least in actuality, for it is not the first actuality/second potentiality of the young's body. However, it may be soul in some lower level of potentiality. And this may be the point in (cI), i.e. that semen is soul potentially. Now according to (II) if semen is a part of the body of a living thing,[388] it must have soul of some kind. And this is what is concluded in (cII). If so the heat

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[386] This suggestion, if correct, can explain the presence of a *logos* in the generative heat without committing us to the reductionist interpretation. Generative heat is different from the heat of fire, for while fire can account for some qualities of the organism it cannot account for the formation of parts with specific functions. These functions are referred to as a *logos* in virtue of which each part is what it is. In the reductionist interpretation this *logos* is attributed to vital heat residing in the *pneuma*. The *pneumatic* heat is purer and superior to that of fire, and hence it can account for properties that ordinary heat cannot. However, Aristotle says that the parts are produced (a) by the movement of the generator who is in actuality what (b) the thing out of which the product comes is potentially. Here (a) is ambiguous between father and movement in the semen. (b) is ambiguous between the material and the semen with its movement. Again, there is no need to read (b) as referring to the material since matter is not what is at stake here. If the referent of (b) is the movement, the referent of (a) must be the generating parent. So the activity of the movement, i.e. its *logos*, is a lower level potentiality with respect to the *logos* of the several parts. Hence this movement is not an actuality to which the actuality exemplified by the fully formed organism can be reduced.

[387] One of the claims the homonymy principle is directed against is the identification of living things with the configuration of their parts, which might have been Democritus' position. [Gilson (1984:12)]

[388] Some qualification is needed here. The semen is not, strictly speaking, a part of the living thing but rather a useful residue. (*GA* I.18 724b29-725a10) However, it is not so radically different from homeomoerous parts of the body, so as for it to be not ensouled. According to I.19 726b3-10 it is produced by concoction from blood, and in cases where it is not concocted properly its appearance is bloodlike. (cf II.3 736a34-5 where it is said that it is impossible for semen to be without some kind of soul)

in the semen seem to be a lower level potentiality and we do not need to conclude that the potential for form is reducible to it.[389]

4.2. The analogy with art and the non-semen emitting animals

A similar picture emerges from the analogy between art and nature. The contribution of the male in generation is likened to the activity of the craftsman: 'it is the carpenter's soul, wherein the form is and his knowledge, which causes his hands to move in a particular way...; his hands move his tools and his tools move the material.' (*GA* I.22 730b17-9) The carpenter's soul is where the form of the art, which is going to be conferred on the material, resides. In that sense it is the first principle of the change. The movement of his hands which is transmitted to the tools themselves moving the material is instrumental for the production of the artifact. Yet it is not on an equal footing with the form in the carpenter's soul, and this is translated into the nature analogue:

> Similarly the male's nature, in those that emit seed, uses the seed as a tool containing movement in actuality, just as in the productions of an art the tools are in movement; for the movement of the art is in a way in them (730b19-23; Balme's tr.)

Nature here must refer to the form of the generating animal. The male's semen and its movement are not identified with this nature. Rather nature is using this movement as something possessing a different actuality from it in order to effect generation. In the art analogue the art or its form in the carpenter's soul is using the movement of the tools to give the appropriate shape to the wood. This instrumental character of the semen, and of the vital

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[389] There is another possible difficulty for the reductionist reading. The semen is said to have soul potentially in the sense that 'it is endowed with the same movement as that in virtue of which the body grows through the distribution of the ultimate nourishment' (II.3 737a18-20 ff.). The movement in virtue of which the body grows is not itself identical with that body. The body is taking its shape by means of this movement. But the movement itself is not identified with the formal parts of the animal. Similarly the movement in the semen that helps as an instrument to transmit the form and assist the generation of the offspring cannot be identified with the offspring itself. So the movement in the semen cannot be identical with, and sufficient for, the form of the generated offspring. Something more is needed for explaining the generation of an individual that possesses the form of the natural kind.

heat by means of which movement is transmitted, is suggested more forcefully by the explanation of generation in non semen-emitting animals:

> But those that do not emit semen, where the female insects some part of itself into the male, act like one bringing the matter to the craftsman. For because of the weakness of such males their nature is not capable of acting through other means, but even when it applies itself directly the movements have barely enough strength; it acts like modellers, not carpenters, since it fashions the thing being constituted not by touching it through something else but directly by using its own parts. (I.22 730b25-31; Balme's tr.)

The part of nature mentioned in the last line of the passage is the part whence the semen is secreted, i.e. the region around the diaphragm. (II.4 738b13-7) This is where the first principle of the animal's life resides and it is a part of the end and the form of the animal while the lower parts, such as the appendages, are for the sake of it. (II.4 738b17-19) Here we have an immediate causal interaction between the form in the generating parent and the material, because of the weakness of the organism's nature.[390] So, in the case of some natural kinds vital heat cannot be an autonomous efficient *aition* of their generation. Instead, the transmission of vital heat from the generating parent to the offspring must be assisted by the direct 'presence' of the form of the generating parent. The end of copulation which marks the end of the actual involvement of the parent's form comes only when the fetation has been set, i.e. when the first principle and the part in which it resides have been formed.

4.3. The contribution of the semen

Further evidence for the reductionist interpretation is sought in the discussion of the semen's physical and psychical contribution. The argument in book I (see 726b18 ff.; 727b15 ff.) was that the female contributes the material out of which the young is formed whereas the male contributes the active *dunamis* out of which this material is made into the offspring. So Aristotle asks whether (a) any portion of the semen survives in the young, and (b) where is

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[390] In these cases male and female 'remain united [in copulation] for a long time, until the male has set the fetation.' (I.23 731a15-16) So where in the semen-emitting animals copulation is short and the setting of the fetation takes several days, in the case of the non semen-emitting animals copulation is much longer and the setting is completed by the end of it. As soon as copulation is over the fetation has already been set. (731a19-24)

the soul coming from, since both semen and *kyema*[391] must be with soul?[392] There are a number of possibilities concerning the origin of soul-parts:[393] (i) they come to be without pre-existing (ii) they pre-exist in the material, (iii) they enter from outside, or (iv) they enter within a body (such as the semen). Since soul-faculties are inseparable from a certain body they cannot enter from outside, (iii). They cannot enter by transmission from some body such as the semen, (iv), since semen is not such a body, but a residue that undergoes change. (II.3 736b25 ff.) Finally they cannot pre-exist in the female contribution (this would render the male's contribution redundant). So the only open possibility is (i). But how is (i) to be understood? It is at this point that the divine element in the *pneuma* contained in the semen, i.e. the special or vital heat, is introduced. So in some sense, soul is associated with the 'so-called hot' included in the semen and making it fertile. Again, this is not fire but a hot nature in the *pneuma*[394] enclosed in the semen, analogous to the element of the stars and included in any material possessing a life principle.

These remarks may give rise to reductionist claims that generation, activities of development and growth, and, perhaps, sense perception as well, can be reduced to the activity of this purest kind of heat, identified with vital heat. However, for this to follow the *pneuma* and the generative heat Aristotle refers to here must be similar to the *pneuma* and heat referred to elsewhere in relation to nutrition, growth, sense-perception. One claim that supports this is that semen is endowed with the same movement with which the body grows.[395] Since the material in the uterus has the same material potentiality as the material

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[391] *Kyema* at 736a31 according to Platt is the unfertilized embryo as opposed to the first mixture of male and female.

[392] The soul is acquired in stages and so the question, at least initially, reduces to the question about the most basic part, i.e. nutritive/generative soul. Spermata and *kyemata* possess this part actually only when they begin to draw the nourishment to themselves and perform the function of nutrition. Up until then they possess it only potentially. (II.3 736b9-11)

[393] Here I follow Balme's interpretation. (1972:160)

[394] As Balme notes this is not the nature of *pneuma*, for *pneuma* contains air. It rather means 'a stuff' inside the *pneuma*.

[395] The movement according to which nourishment is differentiated and directed to the several parts.

used for growth, it follows that when semen enter the uterus it 'constitutes and moves the female's residue in the movement in which it itself is actually moving.' (II.3 737a21-22)

But this picture is controversial. First, as Balme argues the wording at 737b36 merely suggests that '(a) some heat differs in being generative, and (b) that some *pneuma* differs in containing generative heat.'[396] So, Balme concludes, it is only in generation that heat conveys soul-movements. If this is right then the claim in 737a21-22 need not be read as saying that it is generative heat that moves the material in growth, rather than ordinary pneumatic heat. Secondly, the close association between the two kinds of movement must be qualified, for the one belongs while the other does not to a substance that possesses soul as the first actuality of a body potentially having soul. Generative heat as an active power, although regulated by the form does not persist in something that has the corresponding passive power, i.e. the semen, for the semen's body evaporates. What has the corresponding passive power is the matter in the female, and generative heat ceases as soon as it sets the fetation. From then on the movement is regulated by the proportion of active/passive powers in the fetation controlled by the organs that are the result of the setting. So let us examine this operation.

4.5. The setting of the embryo

The constitution or setting of the fetation by means of the generative heat and the transmission of movement is happening as the purest portion of the female residue gets in contact with the purest portion of the male semen. (II.4 739a7) The semen's purest portion is more concocted and thus has more soul-heat. It is thicker and has more body in it. (II.4 739a10-13) Again it is the *dunamis* in the secreted semen that sets up the material. But

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[396] With respect to sense modalities, the organs of smell and hearing are passages full of *pneuma*. (744a1) See Peck's Appendices A, B and Balme (*ad loc.*) for other references. According to Balme the other kinds of heat, such as soul-heat, innate or natural heat Aristotle refers to are no different from ordinary heat. Cf. *Resp* 474a28 for the identification of animal's heat with fire. At *PA* II.5 652b6-15 Aristotle corrects those who identify soul with fire, by saying that soul is constituted (*sunistatai*) by fire. The passage is important because it explains brain's function as controlling the

there is the additional contribution of the heat in the woman's body that helps in drawing the semen inside the uterus. (II.4 739b4-5; b10-15) So the right proportion of heat needed for generation might depend on the heat contributed by both parties, male and female.

One of the arguments for the reductionist interpretation proceeds from the similarity between the setting of the embryo and the curdling of milk by rennet. Rennet is able to perform its activity on the milk in virtue of *vital heat*. Thus, it is argued, the semen's activity is due to a similar kind of vital heat. But this does not immediately follow for there are important dissimilarities between the two processes. In *GA* II.4 739b21 ff. Aristotle explains why the setting of the menstrual fluid by the semen is both (a) for a purpose and (b) the result of necessity by using this analogy: 'the action of the semen of the male in ''setting'' the female's secretion in the uterus is similar to that of rennet upon milk.' (II.4 739b21-23) The reason is that, on the one hand, both semen and rennet contain vital heat, and, on the other, milk and menstrual fluid are of the same nature (cf. IV.8 776a15 ff.).[397] The vital heat integrates the homogeneous substance and makes it 'set' (b23-4):

> Thus when the ''setting'' is effected, i.e. when the bulky portion ''sets'', the fluid portion comes off; and as the earthy portion solidifies membranes form all around its outer surface. (This is the result of necessity; but also it is to serve a purpose: (a) Necessity ordains that the extreme surface of a thing should solidify when heated as well as when cooled; (b) it is requisite that the young animal should not be situated in fluid but well away from it). (II.4 739b27-33)

One of the results of the activity of vital heat is the membrane formed on the surface of the fetation that was set (or on the surface of milk in the analogue case). This membrane is not only the result of necessity. There is also a teleological explanation: the young animal should be situated away from fluid, for its protection and preservation. If the vital heat contained in the male's semen were also a formal cause, i.e. if it included some part of the soul, then it should be sufficient both for the necessary and the teleological explanation. But

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heat in the organism. If heat is associated with normal fire in this context, this indicates how its occurrences elsewhere must be understood.

[397] The similarity between the two cases is first, though briefly, mentioned in I.20 729a11-14. In II.3 737a15 Aristotle goes back to the analogy, only to establish a different point, namely what happens to semen and rennet after the setting of menstrual fluid and milk. (cf. IV.4 771b23 ff.)

first it would sound strange to attribute to vital heat the 'that for the sake of which' the membrane is formed. This would be attributed to the intentions of the cheese-maker or something equivalent. Secondly, if a teleological explanation in terms of vital heat was possible in the case of the setting of the *katamenia*, there should be a parallel teleological explanation in the case where vital heat in the rennet sets the milk. For the two cases are similar both with respect to the nature of the vital heat and with respect to the nature of the material. So it cannot be vital heat that supplies the teleological element in generation. Again if the vital heat were sufficient in the case of natural generation it should be sufficient for the milk/rennet analogue. But this not the case. Generation and curdling are different in that respect, and what accounts for this difference is the fact that in the milk analogue there are no qualitative characteristics controlling the process, analogous to the ones involved in the setting of the fetation and controlling the heat involved.[398] Further in the milk analogue there is no reference to the right proportion of heat as depending on the respective contribution of the two factors, rennet and milk. Given the differences concerning qualitative determinations and the balance between male and female heat, one cannot safely conclude that *vital heat* is active in a similar manner in the two cases.[399] So the passage cannot offer conclusive evidence for the reductionist account. Instead the most plausible candidate for the qualitative determinations present in the setting of the *katamenia* is the natural kind form which grounds teleological explanation. The form uses the ability of heat to heat the *katamenia*, so as to set the fetation and form an outer membrane that will protect

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[398] Except, of course, of those that are due to the activity of the craftsman. In IV.4 772a22 ff. Aristotle argues for a dissimilarity between the two cases which offers something that differentiates them: 'the parallel instance of milk, which was cited, is not comparable, since, in the case of that which the semen's heat causes to take shape, not only quantity is involved but also quality, whereas in the case of the heat in the fig-juice and the rennet, quantity alone is involved.' It must be this difference between vital heat in the semen and rennet, that accounts for the teleological explanation in the activity of semen. So the dilemma between a reductionist and a non-reductionist interpretation is whether the presence of these qualitative characteristics is explainable by the activity of the form of the generating parent. Does the form of the parent uses vital heat as an instrument to which it imparts qualitative powers, or is this a quality of the vital heat in the male's semen not to be explained by appealing to the natural kind form?

it and keep it away from any fluids. This process exemplifies the way in which vital heat is able to carry the necessary movements as an instrument in generation and thus offers an example of the cooperation between material and formal/final causes in generation. I come back below to the character of the qualitative determinations that differentiate between the two analogues, but first let us focus on the case of generation.

What is distinct in the organic case is that once the fetation is set the first principle, which up to this point was existing only in potentiality, becomes distinct and actual.[400] The first principle is identified with the nutritive faculty and is present by necessity from the outset, i.e. 'at the time at when each of the parts is being separated from the rest, since the growth and movement of the other parts are derived from it.' At this stage of development the fetation is potentially an animal but not yet a complete one. (740a24-5) The completion referred to here must be the one that comes when the *kuema* becomes male or female. (II.4 737b11) However since it already possesses the first principle and the heart some level of actuality or completion has been achieved.[401] From then on the parts are gradually formed. This happens because:

(1) the residue provided by the female is potentially the same in character as the future animal will be, according to its nature,
(2) when a pair of factors, the one active and the other passive, come into contact in the way in which the one is active and the other passive (by 'way' I mean the manner, the place, and the time of the contact), then immediately both are brought into play, the one acting the other being acted upon. (740b19-25)

The role of the active and passive factors (the male and female contributions) is again illustrated by using the craft analogy. In art the product is made by means of the movement of the instruments which is the *energeia* of the art. The activity of nutritive soul is similar to

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[399] The analogy focuses on similarities relating to the material conditions of the setting. (739b24-30)

[400] The heart in sanguineous or its analogue in non-sanguineous animals. (II.4 740a1-4; a17-8)

[401] Aristotle's remarks point to more than just two levels of potentiality/actuality pairs, as in the case of the learning or sleeping and the waking mathematician. He says that when the animal is perfected, say at time *t*, it is potentially locomotive. Moment *t* is the moment at which the fetation becomes male or female. Now at *t* the appendages are not yet complete so as to allow locomotion, so it cannot refer to a level of potentiality analogous to the awakened mathematician, but to a lower one.

the activity of the art, both in growth (*auxesis*) and generation. It uses heat and cold as instruments and the resulting movement is the *energeia* of the nature in the sense that the *logos* according to which the parts are formed subsists in it. The difference is that art is the form in something different from what is being produced.

This passage can be understood as saying that *vital heat*, identified with the heat referred to above, is responsible for the development and growth of the organism in virtue of possessing the corresponding movements. However, Aristotle says that it is the movement of the nutritive soul that subsists in the hot and cold. So it is not the movement of hot and cold as such but rather the movement supplied by the soul. The *dunamis* of which this movement is an *energeia* is attributed to nutritive soul. (740b30; 740b36-7) The soul, i.e. the form, which is actively involved in nutrition and generation, need not be read here as equivalent to the element of vital heat. It can be understood as saying that vital heat is an instrument.[402]

Another passage that motivates the reduction of the activity in generation in terms of *pneuma* and vital heat is the discussion of the gradual differentiation of the parts. The differentiation is made by means of *pneuma*. (II.6 742a1) This is not the *pneuma* of the mother nor of the young coming in through breathing: its presence is the result of necessity, because there is liquid and heat present in the embryo the one being active and the other being acted upon. (II.6 742a15-6) Finally, a similar point is derived from the discussion of the formation of uniform parts.[403]

Further, there must be an even lower level potentiality, applying to the potentiality of the animal for locomotion prior to *t*.

[402] At this point, according to Freudenthal's version of the reductionist line, the nutritive soul is equated with vital heat. The movement that persists in simple heat is that of purer, i.e. vital, heat identified with nutritive soul. As we saw above Freudenthal argues that there are two levels of explanation one in terms of vital heat (formal plus efficient powers) and one in terms of nutritive soul (formal powers) plus heat.

[403] 'The heating resides in the seminal residue and the movement and the activity which it possesses are in amount and character correctly proportioned to suit each several part.' The agency of forming the uniform parts is assigned to cooling and heating. This heating and cooling does not work on any casual material, place or time but on material, place and time ordained by nature. (II.6 743a21 ff.) The material (be it first nourishment or some inferior kind of residue) is handed over by nature, i.e.

However, the two passages do not force a reductionist reading. With respect to the differentiation of the parts the account of their formation is relying on a division of parts into three classes which determine the priority relations between them. (742a17-b18) What exists first is the seat of the principle of movement, i.e. the heart, then the upper part of the body which is the end and the whole, and finally the lower parts which are used by the end or the whole. The heart together with other generative parts is playing a pre-eminent role in the formation of the other parts. (II.6 742b35-7) With respect to the *heatings* in the second passage it can be argued that since heat is not intrinsic to the seminal residue it must be regulated by something else.[404] This may be the formal nature, which is using heat and cold because of the capacities they have by necessity. (II.6 743a36-7)[405] So this heat is not a kind of vital heat corresponding to the natural kind and capable of accomplishing the formation of the organism. It is dependent on the ensouled organs producing the right proportion in it so that the organs are formed in the time and location determined by the needs of the organism as a well-functioning system. I shall now turn to these determinations.

4.6. Temporal and spatial determinations in the formation of parts: the formation of sinews

One of the claims supporting the reductionist account is that vital heat is said to be, at least implicitly, inherently proportional.[406] This is derived from the claim that heat resides in the

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by the form of the living organism. (II.6 744b21-7) Again the timing depends on nature's activities. Nature makes nothing superfluous or in vain, hence it does nothing too late or too soon. If it did it would have done it in vain. So, for instance the eyelids are separated only when the heart is strong or capable of moving them, and this comes late. So there is a material necessity that explains the formation of the eyelids in terms of the heatings and coolings involved. Still their formation is governed by teleological reasons concerning the timing of their formation. (II.6 744a36-b3)

[404] According to *GA* II.7 the nature of the semen is similar to that of the brain; its matter is watery whereas its heat is a mere supplementary acquisition. This suggests that the heat is not intrinsic to the semen. (747a18; 750a9; see also Peck's Introduction § 60)

[405] Again see the explanation at 743a37-743b4: heat and cold have of necessity the power of bringing about different results, but in the development of the embryo we find that the one cools and the other heats for some definitive purpose, and so each of the parts is formed. An illustration of such a double explanation is the subsequent explanation of the formation of skin. It is formed on the outside of flesh by necessity, but also for protecting the organism. (II.6 743b8-10)

[406] See Bradie & Miller (1999:81). For Freudenthal since vital heat is identified with nutritive soul it is responsible for supplying the appropriate *logos*.

semen and is correctly proportioned. (II.6 743a26-b5, quoted above).[407] The passage from *GA* II.6, quoted in § 4.2, comes in the middle of the discussion of the formation of parts of the organism, in particular the homeomerous ones. This discussion shows what is demanded by the activity of vital heat if it is to sufficiently explain the formation of the organism.

Homeomerous parts are formed by the agency of the heat and its privation, the agency of cold (II.6 743a4-5), which nature uses as instruments. For instance, it is the cold which 'sets' the flesh. (II.6 743a11) Sinews and bones, on the other hand, are formed by the agency of internal heat. (II.6 743a18) However, Aristotle adds that 'in the case of the forming of the embryo it is for a purpose that their [i.e. heat's and cold's] power of heating and cooling is exerted and that each of the parts is formed, flesh being made soft –as heating and cooling make it such, partly owing to necessity, partly for a purpose -sinew solid and elastic.' (II.6 743b1-6) So the entire passage from 743a4 to 743b6 should be understood as an integral portion of the *GA* aiming at explaining how nature uses heatings and coolings and what justifies such an instrumental understanding:

> The sinews and bones are formed, as the fluidity solidifies, by the agency of internal heat; hence bones (like earthenware) cannot be dissolved by fire; they have been baked as it were in an oven by the heat present in their formation. This heat however, to produce flesh or bone, does not work on some casual material, at some casual time; material, place and time must be those ordained by nature. (II.6 743a18-23; Peck's tr.)

There are three important respects in which an explanation of the formation of sinews by appealing only to the internal heat that solidifies them is insufficient. First, the heat needs to act on the appropriate material. Second, the formation of sinews comes at a determinate

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[407] What is meant by 'inherently proportional' here is not very clear. It may mean that the heat is not by itself of the right proportion, but this proportion is supplied by the father. (II.6 743a26-a34) Or it may be that the father supplied the proportion by generating vital heat, which is inherently proportional. Quite possibly the heat in the material contributed by the mother plays a part in the heat being of the correct proportion. In Freudenthal's account it means that the nature's activity is reducible to vital heat and thus the latter is responsible for the formation of the parts. Bradie & Miller argue (a) that vital heat is the locus of the animating principle (III.1 751b6), and therefore it is animating heat; and (b) that 'vital heat is responsible for the concoction of the semen (II.4 739a11-3), for the integration and constitution of menstrual fluids into a fetus (II.4 39b20-33) and for the concoction of nutrients throughout the life process (III.1 762b7-8; IV.1 766b14-5; V.6 786a17).' (1999:81) Given (a) and (b), the proportionality given by the parent's nature is reducible to vital heat.

stage of the generation process. Third, sinews are located in specific locations in the body.[408] Reference to internal heat alone cannot explain the three crucial aspects. Although no more information is given about any of the three aspects here, something positive can be extracted from two other passages from the *GA* and the *HA*:

> When substances which are fluid but also corporeal are heated, an outer layer forms round them, just as we find a solid layer forming round things that have been boiled, when they cool. All bodies depend on something glutinous to hold them together; and as their development proceeds and they become larger, this glutinous character is acquired by the substance known as sinew, which holds the parts of the animals together. (II.4 737a35-b3; Peck's tr.)[409]

With respect to the question concerning the appropriate material the reference to the fluid and corporeal character gives us some indication as to what kind of material is appropriate for the heat to be exercised upon (if sinews are to be formed). The fluid and corporeal material will have an appropriate amount of heat. As we saw the heat in the material and in the *pneuma* must be such that out of them the right proportion of heat comes to be. So the reference to the fluid and corporeal material could point to a corresponding amount of heat present in fluid and corporeal materials. The proportion between this heat and the one contributed by the father may be the right proportion referred to. This proportioned heat allows the formation of the outer layer which is not only the result of necessity but it is formed also for protection. Further, the glutinous substance is formed in the outer layer, not only by the power of the proportioned heat, but also as the body cools. Thus the cooling, subsequent to the heating, plays an important role as well. There is a more or less determinate limit, for at a certain point the heat diminishes, therefore allowing the cooling process to form the glutinous substance. This limit must be one of the things determining the

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[408] This is how Aristotle's reference to time and place must be understood. For the claim that sinews, unlike blood-vessels, do not constitute a continuous system and do not cover the entire body of the living organism and are to be found in specific locations of that body, see *HA* III.5 515a33-515b14.

[409] The whole passage from 737a34 through to 737b7 is secluded by Aubert & Wimmer, since the paragraph seems misplaced. Peck claims that it consists of remarks taken from elsewhere. This does not necessarily suggest that the lines are spurious.

proportion referred to. The relative decrease of heat is equivalent to a relative increase of the cold. The cooling also depends on the *dunamis* in the liquid and earthy substance which gets formed by the heat, i.e. on the not so well-concocted female contribution. The glutinous substance is not yet identified with the sinews. As the animal develops, sinews themselves acquire this glutinous character in the sense that they are formed out of this glutinous substance:

> The texture of sinew is such that it can be split lengthwise but not crosswise; and it admits of a high degree of tension. Round the sinews a mucous liquid is formed, which is white and glutinous; the sinews are nourished by this, and we can see them being formed out of it (*HA* III.5 515b15-18; Peck's tr.)

Here the temporal stage at which sinews are formed is determined.[410] An essential feature of this stage must be the cooling mentioned above that allows the formation of the glutinous substance. And this, as we saw above, does not depend solely on the vital heat contributed by the semen, for it also depends on the maternal contribution. Generally, if vital heat has formal powers, such as Freudenthal proposes, the temporal succession of the formation of the parts should be accounted for by the activity of vital heat alone. However, the order of the formation of the parts points to the active participation of the organism's form or substantial nature as directing the appropriate kind of material to the corresponding parts.

With respect to the spatial determinations of the sinews in the animal's body we are told that the starting point of the sinews is the animal's heart. (III.5 515a27-8) Sinews, by contrast to blood-vessels, are not continuous throughout the body. They are scattered around the joints and the flexions of the bones. (III.5 515b4-5) The sinews' location in an animal's body depends on their being instrumental for holding together the bones, and enhancing the flexibility of the parts they join:

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[410] The reference to nourishment suggests that sinews are growing out of the glutinous substance as the organism develops. Thus it parallels the *GA* reference to the growth of the organism. This does not contradict the claim that Aristotle might also mean that sinews, once formed, continue to be nourished by the glutinous substance, whatever the exact meaning of nourishment in this context is.

A very important part of the sinews is that in the region which controls the act of jumping (the part known as the ham); another sinew, a double one, is the *tenon*, and those which are called upon for feats of strength, viz. the *epitomos*, and the shoulder-sinews. The sinews which have no special name are at the flexions of the bones: all the bones which are attached to one another are bound together by sinews, and there is a large number of sinews round all the bones (III.5 515b7-13; Peck's tr.)

The teleological explanation of the location of the sinews[411] is re-enforced by the explanation of the absence of sinews from the head. The head is held together by the sutures of the bones, thus no sinews are needed for this function. (III.5 515b14) So sinews in the head would be redundant. This implies that their presence in other parts of the body must be explained teleologically.[412] Now it does not seem that the reductionist reading can sufficiently explain the reason why this amount of heat is directed to areas where sinews are formed and not to others. By contrast, the claim that some parts, such as the heart, play a generative role and direct these heatings seem to make better sense.

4.7. Natural kinds, proportionality and the self-limited vital heat

Another remark supporting the reductionist claim is that vital heat has a self-limiting capacity in producing an animal no greater or less than its natural size. Bradie & Miller make this suggestion on the evidence of IV.4 771b15-772a12, that deals with what determines the number of offspring produced in generation, i.e. the reason why the semen does not turn out one single animal of a fair size, just as in the case of rennet acting on milk. As we saw above, in the rennet/milk case quantity alone is involved whereas in generation it is a

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[411] The sinews are instrumental for the flexing of the bones. As a result they are found in connection with feet, hands, ribs, shoulder-blades, neck and arms. (515b21-2) The expression πρός τήν ισχῦν βοηθητικά in b10 gives the purpose for which they are formed. A teleological explanation of the function of sinews is given in *PA* 654b16 ff. Lennox summarises the reasoning of the passage thus: 'since limbs must bend and straighten, their bones require sinews and either fitted joints or cartilaginous padding' (2001a:217). The fact that there is no explicit teleological explanation in the *HA* passage should come as no surprise since such explanations and the corresponding expressions are standardly absent from these books. (See also Lennox (1990))

[412] The same idea is implied by the explanation why certain kinds of animals have thinner sinews: 'but in those animals which have no flexions in their limbs, i.e. which are without hands and feet, the sinews are thin and difficult to see;' (*HA* III.5 515b24-5) The absence of flexions in the limbs explains the presence of thinner and therefore less powerful sinews.

question of quantity as well as *quality*. (772a23-25) Now let us address again the question whether this quality is determined by the vital heat in the semen.

The quality present in animal generation seems to depend on the contribution of both sexes, i.e. on a proportion between the two.[413] Thus semen might be just an instrument transmitting (part of) this quality. There is a proportion (*summetria*) between male and female, i.e. hot and cold, necessary for generation. (IV.2 767a14-24) So the decisive qualitative determination cannot be solely dependent on a corresponding kind of vital heat appropriate to each animal kind, but rather to a proportion of male and female contribution. This is what produces the difference between the non-qualitative character of the proportion of heat in the rennet/milk case and the qualitative character of the proportion of heat in the generation case. (772a22-25) So the passage does not entail that vital heat in the semen is *self*-limiting, in the sense that it itself produces the appropriate limits.[414]

This casts doubt on another requirement of the reductionist account for vital heat, namely that there should be a one to one correlation between animal kinds and kinds of vital heat.[415] This is not to say that the differences between animal kinds with respect to value are not reflected in their difference in heat.[416] What the *GA* does not unambiguously confirm is that there is one kind of vital heat assigned to each kind. Instead the vital heat used by organisms of one kind may vary so that it is sometimes deficient or excessive, hence resulting is some deformity in the offspring. (743a27-30) Vital heat may fail to possess the right proportion. Whether it does depends on the capacity of the generating parent to

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[413] In the lines devoted to *sperma* Aristotle says that if the male emits more semen this will not make anything bigger but on the contrary will dry the material up and destroy it. (772a10-13) He draws a parallel with boiling water where increase of fire, from a point on, does not entail increase in the water's temperature. The water just evaporates more quickly. This analogy points to the significance of the contribution of the female. The limit is not solely dependent on the vital heat provided but also on the kind of material it is working on. So there must be some proportion between male and female contribution. (772a17-22)

[414] While the *dA* 416a9-19 remark explicitly suggests that it is the soul's capacity which sets the limits of development.

[415] Freudenthal himself seems to be taking this line.

[416] For instance, heat in the blood is related with perception and intelligence and in *PA* II 648a2-11; see also *GA* II 744a29. Animal size also is related to heat in *GA* II.2 732a18-21.

produce sperm with the right proportion. In the reductionist idiom vital heat may or may not carry all the properties that constitute the 'program' corresponding to the form of the kind in question. The range is dependent on the concoction of the sperm.[417] So, it will have the right proportion when the form of the generating parent is able to supply it through concoction. If so it is not just vital or soul-heat corresponding to a natural kind that generates a perfect animal of that kind, but sperm with the right amount of vital heat being supplied or regulated by the parent's nature or form.

There is a further point to be made here. The reference to the right amount of vital heat points to the right proportion or *logos* that the vital heat must possess. Freudenthal views this *logos* as the formal component of vital heat. But now this *logos* has its origin in the concoction effected in the generating parent. Concoction plays a determining role both for nutrition, (i.e. the processing of food and the production of blood or its analogue appropriate to the natural kind to which the entity belongs) and generation (i.e. the production of the sperm of the male and the *catamenia* fluids in the female).[418] In both processes differences with regard to concoction and thus differences in vital heat characteristic of different animal kinds are not attributed to differences of some material nature. This implicitly suggests that the differences depend on form or substantial nature of the kind. [Lloyd 1996:100)] The active involvement of the kind-form is also suggested by the role of heart, liver and the guts, which are parts of the substantial nature of the organism,

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[417] The more the sperm is concocted the more fertile it is because it has more vital heat. See *GA* II.4 739a9-13: 'just as the most fluid portion of the male semen is [purest], and in most cases the earlier discharge during any one emission is less fertile than the later, because it has less soul-heat owing to its being unconcocted, whereas that which has been concocted is thicker and has more body in it.'

[418] For concoction with respect to nourishment see *PA* II.3 650a2-b1, *GA* I.18 752a3-. For the relation between concoction and the production of semen see *GA* I.6 718a2-10, I.18 725b19-25, II.4 739a7-13, III.11 762a36 ff.. The different discussions in which concoction plays an explanatory role are registered by G.E.R. Lloyd. (1996:83-103) He distinguishes five principal areas in the animal world where the operation of concoction is crucial, all of which point to aspects of generation: (1) production of the semen; (2) production of the menses; (3) the action of the semen on the menses; (4) the female's contribution to the embryo's concoction; (5) differentiation of the parts of the growing embryo. (1996:91)

in the production through concoction of the appropriate kind of heat.[419] If concoction is dependent on the form or essential nature of the generating parent, and vital heat depends on concoction it follows that vital heat is dependent on the form. Hence vital heat alone cannot necessitate the generation process.

4.8. Reductionism and the Pangenesis Theory

Finally, the reductionist interpretation of vital heat as efficient and formal cause seem to have some similarities with the theory of *pangenesis* criticized in *GA* I.18. These similarities turn on an objectionable feature of the *pangenesis* theory. According to Aristotle's version of the *pangenesis* theory the semen is drawn from every part of the generating parent, thus explaining the resemblance between generating parent and offspring. Aristotle puts forward a number of difficulties for this theory by assuming that the semen should come either from the uniform or the non-uniform parts or both, and arguing against each of the three alternatives. In 722a28-722b3 he criticizes the latter alternative by an objection which seems applicable to the reductionist interpretation of vital heat as well:

> The semen may be drawn from both uniform and non-uniform parts... The non-uniform parts are constructed out of uniform ones assembled together; so that being drawn from the non-uniform parts would come to the same thing as being drawn from the uniform parts plus the assemblage of them. (I.18 722a28-32; Peck's tr.)[420]

It is impossible for the semen to be drawn from the uniform parts plus their assemblage, because the assemblage is not the sort of thing the semen can be drawn from. Now a similar objection can be turned against an interpretation of vital heat as formal and efficient cause. In what sense can vital heat be said to contain the assemblage of the parts of the animal?

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[419] In *PA* II.3 650a13-4 the upper and lower guts are concocting the food by with the aid of natural heat. For the role of heart and liver see *PA* III.7 670a23-9.

[420] The passage continues thus: 'It is just like the case of a word written down on paper: if there were anything drawn from the whole of the word, it would be drawn from each of the syllables also, and this of course means that it would be drawn from the letters plus the assemblage of them together. Now flesh and bones, we should agree are constructed out of fire and the like substances; which means that the semen would be drawn from the elements only, for how can it possibly be drawn from the assemblage of them? And yet without this assemblage the parts would not have the resemblance;

Even if vital heat carries the right proportions of temperature, longevity etc. so that it can produce the appropriate qualitative characteristics of the uniform parts, how can it possess their assemblage? What the reduction to vital heat has difficulty accounting for is the unity of the organism. If this objection can be turned against the reductionist reading that vital heat has both formal and efficient powers in generation and directs this process, it makes it unlikely that Aristotle held such a position.[421]

In the above discussion I tried to give reasons for the claim that vital heat, and a fortiori any other material element, cannot sufficiently explain generation processes, and that therefore it is impossible to reduce the form's activity in generation to the activity of a material element such as vital heat. Vital heat is rather a special kind of instrument nature uses in order to recreate the same form through generation.[422]

5. Conclusion: persistence and non-sufficiency

Both the strong irreducibility and the reductionist theses agree that elemental matter does not organize itself spontaneously into individuals belonging to any one of the eternally

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so if there is something which sets to work later on to bring this assemblage about, then surely this something, and not the drawing.' (722a32-b3)

[421] The directive character of vital heat is one of the attributes on which the Bradie & Miller interpretation is based. They derive that from the discussion of the growth of the eggs of some fishes. (III.4 755a11 ff.) These eggs are expelled while very small but they grow quickly. Growth is not due to any attachment, e.g. umbilical cord, but to the more solid portion turning fluid and the fluid turning into *pneuma*: what creates that is the nature of the ψυχικόν θερμόν, likened to the way in which yeast grows by means of heat. (755a20) Bradie & Miller take this to suggest the directive agency of vital heat in generation. Yet, Aristotle adds that this cause, containing a yeast like residue, accounts for necessity while eggs also grow outside the uterus, 'for the sake of the better, since it is impossible for them to obtain all the growth in the uterus owing to the prolific habit of these animals.' (755a26) It is the latter reason that should be considered as directing their formation. And vital heat does not suffice for explaining this. But perhaps this objection begs the question against the Bradie-Miller interpretation, since their point is that vital heat is sufficient for things happening for the sake of the good. In any case I think that what happens for the sake of the good is the eggs grow *on the outside*, i.e. they are expelled, while what vital heat ensure in this context is that they *grow* on the outside, i.e that they do not shrivel up and die.

[422] A similar view is expressed by Verbeke. He claims that vital heat is not an instrument independent of the psychic activity (1978:206). The soul power of the organism corresponding to the form of the species in which the organism belongs plays a formative role in the composition of the corresponding vital heat which can be used as an instrument for the development and functioning of

persisting, persisting through natural generation,[423] kinds of living things. What they disagree on is what additional explanatory principle(s) are needed in order to explain (a) the persistence of the species, and moreover (b) the persistence of individual entities belonging to these kinds. For the strong anti-reductionist it is the form of natural kinds that play such a role. For the reductionist, on the other hand, an intrinsic efficient cause, such as the element of vital heat, is sufficient for generating living things. This account of vital heat is proposed as an explanation both of the persistence of natural kinds and of the persistence of living organisms throughout their life histories.[424] I argued against the line that vital heat, instead of the natural kind form, is the formative power in generation.

One alternative candidate for this explanatory role, as suggested by Cooper, is the form of each natural kind as a goal. Forms are the bedrock in the explanation of the persistence of those kinds. Forms are natural goals and whatever promotes their persistence, including reproduction, is worth pursuing. So, the existence of forms as goal explains persistence both of the individual and the species.

Or one may reach for some further explanation. There are passages suggesting that a kind of organisms possessing form *F* persists through reproduction because being an *F* in full actuality is better than not and this is what the exercise of reproductive capacity does.[425] And this value seems to be a principle of the physical world (both super-lunary and sub-lunary). Moreover, in at least one passage (*GA* II.1 731b23), persistence of kinds follows from something explanatorily prior, ἄνωθεν. Reproduction is the means through which some prior teleological principle is geared to the (sub-lunary) world. But these points need not be read as references to a universal cosmic nature over and above the various natural

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the organism. For an examination of Aristotle's account of spontaneous generation, as supporting the same point see *Appendix III*.

[423] Freudenthal makes here the further point that matter cannot organise itself spontaneously into *any* kind of living thing (1995:37). This claim, as argued in *Appendix* III is controversial.

[424] That is vital heat can offer an answer both to the question of the persistence of natural kinds (PNK) and the question of the sufficiency of material causes (SMC).

kinds. Rather these passages suggest a strong connection between the completion or excellence characteristic of a kind and the exercise of a number of capacities including at least the generative/nutritive one. The activities corresponding to these capacities are identified with the form of the kind. The generative/nutritive capacity is the activity that grounds, the direction of, all other capacities constituting the characteristic life activities of each living kind, and therefore it constitutes a minimum for possessing life.

The *GA* opens with a discussion in book I of natural and unnatural generation. The discussion suggests that teleology applies to organisms through the reproduction process. Reproduction in the sub-lunary world happens because it is for an end as something good, i.e. reproducing the form of the kind in full actuality. In this chapter, I argued that vital heat is an instrument by means of which living things reproduce. Through the activity of vital heat persistence of the kind is achieved. It is through concoction and through the proportion implanted to vital heat that living things can reproduce. So the sub-lunary world contains an element instrumental to the natures of living things for exercising their natural capacities. More importantly the mechanism of reproduction by means of vital heat is the same mechanism that controls the formation and maintenance of an organism's parts and functions throughout its life-span. It is the fact that both generation and functioning are controlled by the same mechanism which grounds teleological explanations. The same activity ensures that the parts of living things are formed and function so as to protect and enhance the continued existence of the organism. This associates the teleology exemplified by the reproduction of living things to the teleology exemplified by the functions of their parts. In that respect the two teleologies seem to form a continuum in Aristotelian biology.[426]

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[425] *dA* II.4 415a25; 415b1-7; *GA* I.1 715a18 ff. (See also II.8 747b28 on the sterility of mules).

[426] The difference between *the two teleologies* is equivalent to the distinction examined by David Charles between processes of formation of organisms occurring for the sake of the whole organism, and parts of organisms which are present for the sake of the whole organism. (1991:104) Charles argues that the evidence from *Physics* II.8 199a6-8, 30 is not decisive on whether one or the other case is more basic. (1991:105) This claim is discussed in ch. 9, section 5.

The close connection between the two levels of teleological explanation is also suggested, first, by Aristotle's discussion of the order of the formation of the parts of organisms, and secondly by the close connection between generative and nutritive faculties of the soul. With respect to the order of formation, the account is influenced by considerations relating to the functional role of those parts. The order of formation follows the connections between the functional roles of the parts in the organism as a whole. With respect to the association between generative and nutritive soul-faculties, the attempt to incorporate the two activities into one basic function can be viewed as an attempt to link teleological explanation in animal generation with the functional account of an organism's parts. Further, these two issues offer insight into the features that are included in the substantial nature or essence of living kinds. I will turn, first, to the account of the formation of the parts of living things, then I will consider the relation between their generative and nutritive powers.

1. Introduction

Aristotle's account of the order the development of organisms follows, is relevant to the overall discussion in two respects. First, it re-enforces the claim that vital heat is not sufficient for the development of the animal and therefore cannot be considered as both an efficient and a formal cause. Secondly, and more importantly, the order of formation conforms to a corresponding teleological ordering of the activities and parts of the organism, and its examination reveals this order. The teleological order, and the developmental order implied by it, determine a division of animal parts in a way that supports a distinction between essential and non-essential ones. Therefore the account of the development of an organism reveals what necessary features are essential/definitional to it.

2. Heart as the first principle in generation

Although Aristotle insists that the essence of soul cannot be corporeal, he claims that 'it [presumably the soul] resides in a bodily part that is among those which have control over the rest.' (*JSMV* 1 467 b13-16) This part is identified with the heart in sanguineous animals or what is analogous to the heart in non-sanguineous ones.[427] Heart is the seat of nutritive and generative capacities of the organism.[428] This is so because the central positioning of the heart is best for the functioning of those faculties and nature does what is best, among the available possibilities. Further, an indication of the central role of the heart is that in the

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[427] This complication does not affect the above discussion. The points that follow apply, *mutatis mutandis*, to non-sanguineous animals.

[428] It is also the seat of perceptual and locomotive capacities. Aristotle argues for the situation of both nutritive and perceptual capacities in one and the same organ from a principle of economy. (*JSMV* 1 467b24-6) What justifies the implicit application of such a principle is that nature does what is best. Similarly the identification of this bodily organ with the heart is based on the premise that the position of the heart is optimal for the operation or activities of the corresponding capacities. (*JSMV* 1 467b28-a1; see also *PA* III.4 665b18-22) However, the inference is based on observational facts and most pre-eminently the fact that heart is formed first in the order of development. (468a28-32) (cf. Tracy (1969:183)) The *PA* suggest two additional positive reasons for the candidacy of heart. The part in question must be simple and it must be one of the non-uniform parts. Heart is both simple and non-uniform. (See II.1 647a24-31 with Lennox's comments)

process of development it is the very first part to be formed. Equally the fact that death is caused by the failure of this organ indicates that the creature's essential nature resides in it.[429]

Heart is regarded as the center and source of heat in living things, heat which is used as an instrument both in the formation of the parts and in the self-maintenance of the organism.[430] Apart from heart's early formation and the simultaneous failure of life and heart's activity, the fact that heart is the place where blood is concocted and then distributed as nutriment to the other organs of the living body through the vascular system, suggests to Aristotle that heart is responsible for the maintenance of the necessary heat for development, nutrition and growth.[431] However, in order for the right kind of heat to be preserved the moderating activity of a cooling factor is necessary, so that the heat is counter-balanced and stabilised. This function is attributed to the activity of the brain.[432] However, heart's heat and brain's cold are themselves the result of a balance between opposing powers of heat and cold within each organ. These powers must be regulated in order for the correct proportion to be preserved. The structure of the living body depends to some extent to the maintenance of the proper blend between hot and cold. For that purpose heart is divided into three chambers, whereas blood vessels in the head are constructed accordingly to the requirement of maintaining the desired proportion of heat and cold.[433] In virtue of these properties as well as in virtue of their location in the body of the living thing the two central organs are able to maintain their internal balance. Further, by having the right proportion the two central organs interact so as to secure the right blending of heat and cold in the living thing.

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[429] At *PA* III.4 665a31-4 the formation of heart and liver is almost simultaneous with the constitution of the organism. (See also III.5 666a19-21). For the connection between death and heart's failure see *dR* 17 478b32-4; *GA* II.4 741b18-24.

[430] *JSMV* 4 469b8-20; cf. Tracy (1969:184-5).

[431] The role of blood in nutrition and the role of the heart in the concoction of nourishment is explained in *PA* II.1 647a34-b9; II.3 *passim*. See also *GA* II.4 739b34; II.6 743a1-6.

[432] The brain and its functions are discussed in *PA* II.7. Its presence in living things is for the preservation of their natures. (652b6-7) Brain does so by moderating the heat produced by the heart. (*PA* II.7 652b15-20; *GA* II.6 743b26-33)

[433] The three cavities of the heart are discussed at *PA* III.4 66b10-667a5. This structure helps in balancing the heat of the blood. A similar proportion is required for the brain. (*PA* II.7 652a27-33)

By means of this explanation Aristotle attributes the governing of life to these two central parts. (*PA* III.11 673b12)

The central role of these organs suggests that an account of what a living thing is should include references to the structure of the parts and to their function. Their structure and function are crucial for the explanation of further natural features of the animal kind they belong to, and thus they must be part of the essence and definition of these kinds, in at least one understanding of what these essences are. Does this mean that they are part of the form of the organism? Some considerations suggest that they are. First, as we will see below, these parts are parts of the end or final cause. Further, heart in particular is the seat of the first principle of the animal's life, and it is closely associated with its soul. Also its active role in development can be seen as evidence for the active participation of form in the formation of living things. On the other hand, there are material aspects which become crucial in defining these parts, so that it seems as if they cannot be part of the form, at least in the restricted sense in which soul is form. What is clear, however, from the biological explanations is that there will be some accounts of what a living thing is that will include reference to such organs. So there must be some conception of what a thing is, presumably weaker than the one applying to primary accounts of what the essence of an entity is, which is applicable to the explanations of organisms as material beings.

The formation of the heart happens when the fetation has 'set' (739b34-5), so it marks-off the setting of the embryo. From this moment onwards the fetation has a first principle, a principle of growth. Before the setting, the principle is contained in the movement of the semen but it is not yet a definite thing. (734b18-19) It is only when heart is formed that a definite thing comes to be, and the rest of the parts are gradually completed:

> So too in the fetation, in a way all the parts are present potentially, but the first principle has made the most headway, and on that account the first to become distinct in actuality is the heart. This is not only plain to the senses... but also to the reason. Once the fetation which has been formed is separate and distinct from both parents, it must manage for itself, just like a son which has set up a house of his own independently of his father. That is why it must

have a first principle from which also the subsequent ordering of the animal's body is derived. (II.4 740a2-9; Peck's tr.)

Heart is the first principle out of which the ordering of the development is derived. Empirical evidence suggests that the formation of the heart happens early in the development and this is an indication of it being the first principle. The reason, however, that this is so is that there must be such a principle responsible for the subsequent developmental changes of the living thing once the animal gains some autonomy from the generating parents. So the formation of heart marks off the point at which the living thing becomes a separate autonomous and determinate individual. From then on the heart acts as the first principle responsible for the ordered formation of the parts of the animal, uniform and non-uniform alike. (740a18-19) This happens as soon as the animal begins to need nourishment. (740a20-22)[434] So heart is the principle responsible for the nutritive function of the organism, among others functions. Heart's contribution in the development of the parts, can be extracted by the following general explanation of the formation of animal parts which appeals to two reasons:

The true reason why each of the parts is formed is that the residue provided by the female is potentially the same in character as the future animal will be, according to its nature; and although none of the parts is present in actuality in that residue, they are there potentially. A further reason is this. When a pair of factors, the one active the other passive, come into contact in the way in which the one is active the other is passive (by 'way' I mean the manner, the place and the time of the contact), then immediately both are brought into play, the one acting the other being acted upon. This is explained by the joint activity of the appropriate active and passive powers. (740b19-25; Peck's tr.)

So the first reason is that the passive potentiality of the material provided by the female is such that it possesses the power to become what the developed animal will be in actuality, i.e. in first actuality. The second is that as soon as the passive power and its corresponding

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[434] Aristotle offers an argument in 740a19ff. (cf. 735a20 ff.) for the claim that heart is the principle of blood-vessels. Heart is the principle of a living thing when it needs nourishment for everything that exists needs to grow. The ultimate nourishment for a living thing is blood or its analogue; blood-vessels are the receptacle of blood; therefore heart is their principle. So Aristotle believes that heart is the principle of the distribution of nourishment and of the activity of nutrition.

active principle, i.e. the principle of movement provided by the father, come into contact in the right way, then immediately the latter is acting upon the former and the former is being acted upon by the latter. The formation of the parts is the result of this interaction. It seems that the contribution of the heart in ordering the development must be that of the active power acting on the corresponding material. So let us examine the activity of this power involved in the development of the organism:

> The products which are formed by human art are formed by means of instruments, or rather it would be truer to say they are formed by means of the movement of the instruments, and this movement is the activity, the actualisation [activity] of the art, for by 'art' we mean the shape of the products which are formed, though it is resident elsewhere than in the products themselves. The *dunamis* of the nutritive soul behaves in the same way. Just as in the independently existing animal or plant, his Soul [$S_{Nutritive}$], which uses heat and cold as its instruments ... at a later stage produces growth out of the nourishment supplied, so in precisely the same way at the very outset, this Soul [$S_{Generative}$], while the natural object is being formed, causes it to be set and constituted; since as the matter from which the object derives its growth is identical with that out of which it was originally set and constituted, so too the *dunamis* which fashions the object is identical. And this part of the soul it is which is the nature of each several object. (II.4 740b26-741a1; Peck's tr.)

Aristotle draws on two analogies here. The first one is between the role of the active power in the production of artifacts and the active power belonging to nutritive soul. The way a craftsman produces an artifact by means of the movement of his instruments, which is the activity of his art, is parallel to the active power of the soul during the development of the organism. Nutritive soul is the analogue of the art and the corresponding instruments are heat and cold. The movement through which the *dunamis* of the soul becomes active subsists in them. Here the second analogy is introduced, supporting the claim that the power responsible for growth is identical to the power generating the organism, i.e. the power that sets the fetation. The analogy holds between the two pairs of passive/active powers involved in generation and growth: if the passive powers involved are identical the same must be true for the corresponding active ones. Now, the matter from which the organism derives its growth is identical to the matter from which it was originally constituted, concocted blood. Hence, the active power from which the organism derives its growth must be identical to the

active power responsible for the setting of the fetation. If the movement of growth is the activity of the *dunamis* of the nutritive soul, it follows that the movement which constitutes the setting of the fetation must be the activity of the nutritive soul as well. This analogy is crucial because on it rests the identification between nutritive and generative soul, i.e. the identity between S_N and S_G above.

However, there is a complication which will be considered in more detail in the next chapter. If by growth here Aristotle refers to a mere quantitative alteration, then an intermediate stage between the setting of the fetation and these quantitative alterations, which is constituted by the process of the actual formation of the several parts, seems to be omitted in the above explanation. As Aristotle mentions more than once, the principle is formed first then the other parts are formed, the internal ones earlier than the external ones (740a12 ff.; 741b25-6). So it is not the case that all the changes an organism undergoes once the first principle is set are mere quantitative alterations. A number of changes relate to the completion of the generation process. At least two possible interpretations can be suggested. First, Aristotle speaks loosely with regard to the sub-divisions of the nutritive process. So, he lumps together under the rubric of growth two kinds of changes in the organism for which the activity of nutritive soul is responsible, namely perfection of the organs and quantitative alterations; two kinds of changes which he carefully distinguishes elsewhere. So this suggestion amounts to saying that growth here is used in a generic way which includes development as well as increase. The second possibility is to understand growth here in a way that excludes quantitative changes. One indication suggesting the latter reading is the claim that the two processes consume the same kind of material. As it will be argued below at *GA* II.6 744b34 the quantitative nutritive changes do not consume the same kind of material as the non-quantitative, substance-formative ones. It is only the latter kind of material that is identical to the material used in generation. In either case, whatever the exact

way growth is used here, it includes changes due to nutrition identified as developmental ones.

If this identity between S_N and S_G holds then whatever is responsible for the growth of a living thing is also responsible for its generation. Since the heart of sanguineous organisms is the active power that orders the development of their parts, the heart must also be the first principle in generation and the organ in which the nutritive-generative faculty first exists.[435] Heart plays a moderating role in the generation of the organism maintaining the equilibrium necessary for the formation of the parts. So the heart is both an efficient cause contributing to the development of the organism and part of its formal nature, controlling a number of other soul-functions,[436] while heat is the appropriate instrument for these functions.

3. The temporal succession in the formation of the parts

The heart of the animal is the first part to be formed and this is where the first principle resides, i.e. the principle of the generative and nutritive capacities of the animal. Once the heart is formed the rest of the parts are formed one by one by means of *pneuma*.[437] *Pneuma* itself, and its activity, is the result of the interaction between the hot and the cold element. However, the order of the formation of the parts is not dependent on *pneuma* but it depends on the parts formed earlier in the order of development, starting with the formation of the heart, which is a principle for the formation of the subsequent ones. This order is relative to

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[435] Vital heat and *pneuma*, on the other hand, are mere instruments used by the part responsible for growth and generation. Their role in generation must be similar, they are instruments used by the part of the soul responsible for generation. At *GA* V.8 789b3 ff. *pneuma* is compared with instruments used by the craftsman, such as the hammer and the anvil of the smith.

[436] So Verbeke (1978:198). The soul has a formative role in the process of development. The embryo is formed by the soul, initially the soul of the generating parent and from the formation of the embryo onwards by the soul of the developing living thing. According to Verbeke this is not incompatible with Aristotle's entelechism, and does not suggest any form of dualism, since the instrument itself, i.e. the heart is constituted by the psychic principle. (1978:204)

[437] In 741b37 the parts are differentiated by means of *pneuma*. This *pneuma* is not coming from the female's contribution nor is it coming from outside but it is σύμφυτον (connate). For the claim that *pneuma* is neither inherited by the mother nor due to the organism's respiratory system see *GA* II.6 741b37-38. *See* also Peck (*ad.loc.*).

the needs of the developing organism. Roughly, the principle underlying the discussion of the formation of the parts of an organism during its generation process is this:

(PF) For any part, p, of a living thing, l, serving a function f, p is formed at stage, s_n, of the developing process of l iff f is useful for l at s_n.

The order of formation relies on priority relations between the parts grounded on teleological relations:

> As with everything else, so with the parts of the body: one is, by nature, prior to another. But the term 'prior' at once comprises a variety of meanings. E.g. take the difference between [a] that for the sake of which a thing is, and [b] that thing which is for its sake: of these, one [b] is prior in point of formation, while the other [a] is prior in point of being or reality. (II.6 742a19-23; Peck's tr.)

Parts prior in being, or naturally prior, are those for the sake of which the naturally posterior parts are formed. The passage also introduces the idea that the order of natural priority is the converse of the order of temporal priority (though this will be qualified in a moment).[438] Aristotle, however, distinguishes two ways something can be for the sake of something else. This introduces the following three-fold division of animal parts:

> Further 'that which is for the sake of the End' comprises two divisions: (I) that whence the movement is derived and (ii) that which is employed by the end; or in other words (i) something which generates, and (ii) something which serves as an instrument for what is generated. Of the two the productive factor must exist prior to the other: e.g. a teacher must exist prior to the learner, while pipes are posterior to the person who is learning to play them: it is superfluous for people who cannot play pipes to possess them. So we have these three things: (1) the end which we describe as being that for the sake of which <other things are>, (2) the things which are for the sake of the end, viz. the activating and generative principle (second because the existence of that which is productive and generative, qua such, is relative to what it produces and generates); (3) the things which are serviceable, which can be and are employed by the end. (II.6 742a23-33, Peck's tr.)

Animal parts are classified with respect to nature, being or honor in the following classes: (1) the end, i.e. the whole animal, (2) the generative/instrumental parts, and (3) the purely instrumental ones. The end itself is naturally prior and temporally posterior to any individual parts. Then some parts are for the sake of this end in the sense that from them the movement

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[438] Cf. *PA* II.1 646a24-6. The contrast between natural and temporal priority holds only between the generative parts and the whole animal.

that produces the whole animal is derived. Heart is one of them, acting as an efficient cause in the development of the animal. (II.6 742b5 ff.; 742b35-743a1) Since generating parts are generative of the end they must be temporally prior to it. Further, since the relations of temporal priority are the converse of the relations of natural priority, generative/instrumental parts should also be posterior in nature to what comes late in the formation of the organism, i.e. instrumental parts. But this is not so. Parts that are instrumental or serviceable to the end, are posterior in nature both to the end and to the generative/instrumental parts. They are the less honorable parts, and thus the last to be formed:

> Thus first of all there must of necessity exist some part in which the movement resides (for of course this is a part of the End, and the supreme controlling part of it); after that comes the animal as a whole, i.e. the End; third and last of all come the parts which serve these as instruments for various employments. If it is true, then, that there is a part of this kind – a part which contains the first principle and the End of the animal's whole nature- which must of necessity be present in an animal, then this part must of necessity be formed first of all- formed first *qua* activating, though formed along with the whole creature, *qua* being a part of the End. Thus, those instrumental parts which are in their nature generative must always be there themselves prior to the rest, because they are for the sake of something else, as being a first principle; those parts which, although they are for the sake of something else, are not generative, come later. (II.6 742a33-b7, Peck's tr.)

At least two questions arise here. First what kind of necessity relates generative parts to the end, i.e. what kind of necessity is referred to in the first line of the passage? Instrumental-generative parts are not just for the sake of the end. They are parts of this end, i.e. what acts as the efficient cause for bringing about this end is a part of it. If this is so then the necessity linking the heart to the whole animal may not be conditional necessity, but it might be simple unqualified necessity.

Secondly, if heart is a part of the end and for the sake of it as a first principle, why is it demoted in the order of natural priority as posterior to that for the sake of which it exists? One reason may be that generative parts are temporally prior to the whole organism. Aristotle often contrasts temporal with natural priority and he does so also in a biological context, in *PA* II.1 646a24-6. In general he seems to follow sometimes the strong principle that what is temporally prior is naturally posterior. Another reason might be that a part is

always naturally posterior to the whole it belongs to. (*Met.* V.24 1019a9) It follows that any generative part will be posterior to the whole, even though it is responsible for its generation. But there is a further and possibly stronger reason for the priority claim. The generative part is incomplete in the sense that it is generative of something other than itself, namely the whole animal. Aristotle points to this reason in 742a30: 'the existence of that which is productive and generative, *qua* such, is relative to what it produces and generates.' It is this feature that makes generative parts naturally posterior to the whole animal. The teacher is naturally posterior to the learning (although prior in time both to the learner and the learning) because his being *qua* teacher is determined by means of the learning process. (742a25-7) Equally in any natural process the activating factor's being is determined by the outcome its activity aims at producing. In the case of generation this is the complete living thing.

The relation between temporal order and order of honor is offering an empirical test for the threefold division of animal parts. First come those instrumental parts that are generative because they are for the sake of something as a first principle. (II.6 742b3-6) Second, come the parts that constitute, together with the first principle, the whole animal, the end of the generation process. These parts are identified with the upper portion of the body of the living thing (742b13-6). Both kinds of parts play a basic role, ontologically and explanatorily, and therefore should be included in an account explaining the substantial nature of the kind. Finally, purely instrumental parts are posterior both in the order of nature/honor, and in the temporal order of formation. So last in the order of formation and the order of nature come parts that are purely instrumental, such as the lower portion of the body.[439] The biologist is able to derive relations of natural priority between the parts, and

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[439] Aristotle refers to empirical observation that vindicates his threefold division of animal parts: 'And on this account the part which contains the first principle is the first to be formed; then follows the upper portion of the body; and that is why in embryos we see that the parts round the head and eyes are largest at the outset, while the parts below the umbilicus, for instance, the legs are small. The reason is that the lower portions are for the sake of the upper portion, and they are not parts of the End nor are they concerned in generating it.' (II.6 742b12-17)

search for the functional relations that ground them, from observing the temporal order of the formation of the parts.

In general, there are at least two difficulties with the above three-fold division of animal parts. First it is not obvious that a clear-cut distinction can be drawn between the different kinds of parts.[440] Since the division between parts of the substantial nature, or essential and non-essential ones, must depend on this three-fold division, if the latter is vague so must be the former one. The second difficulty concerns the modal relations between the three kinds of parts. Let us turn to the latter difficulty first.

Once Aristotle has outlined his account of the formation of parts he turns to Democritus' account and mounts the following criticism. The weakness of the Democritean account consists in its failure to state the necessity involved in the cause.[441] What kind of necessity Aristotle has in mind is not immediately clear. On the one hand, the relation between the generative parts as parts of the end, and the end itself must be a case of simple necessity, in the sense that these parts are not merely the means for bringing about this end. The simple necessity here between some parts and the whole could be understood as a case where the two terms are metaphysically simultaneous, none is ontologically prior to the other (though it may be so temporally). On the other hand, the relation between parts as instrumental for the end they produce must be a means-end relation, a relation of hypothetical necessity. In that respect there is an ontological priority.[442] Perhaps the double role attributed to generative parts, as both instrumental and constitutive, tries to emphasise

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[440] Hence it is not always safe to draw the distinction relying on the temporal criterion. It is not easy to determine 'whether those parts are prior which are for the sake of something else or that part for whose sake these other are present.' (II.6 742b7-9) The reason the distinction is not clear-cut is that the activating parts intrude themselves into the picture, because in formation they are prior to the end, hence it is not easy to divide between the activating and the instrumental parts. (II.6 742b9-10)

[441] 'People who say like Democritus of Abdera, that 'this is how they [i.e. the living things] are always formed' and regard this as a starting point in these cases make a mistake, nor do they even succeed in stating the necessity involved in the cause.' (II.6 742b18-21) Presumably the strength of Aristotle's own account consists in its being successful in that respect.

the view that although they are in one sense instrumental they are not merely related to the whole with hypothetical necessity. Now the charge against the Democritean account is the following:

> Their argument is this: what is limitless has no starting point; but the cause is a starting point, and what is always is limitless; therefore (says Democritus) to ask for a cause in connection with anything of this kind is the same as trying to discover a starting-point in something that is limitless. Yet on this line of argument, on the strength of which they try to dispense with trying to discover the cause, there will be no demonstration of any of the 'eternal' things. It is obvious, however that demonstrations of these (some of them which always come to be, some things which always are) do in fact exist. (II.6 742b21-6; Peck's tr.).

The charge points to the theory's failure to explain the eternal persistence of animal kinds. For Aristotle, as it was argued in ch. 6 section 2, the persistence of animal kinds must conform to principles (P1) and (P2), and this can be achieved through natural generation. Male and female contribute the corresponding active and passive powers through which nature achieves the persistence of the kind-form in full actuality. This instrumental character of generation points to conditional necessity, relating the generative parts to the aim of persistence of the kind. On the other hand, the generative parts are parts of the end and as such they must be related to the whole by simple necessity.

Further, the contrast between generative and purely instrumental parts suggests that the two sets of parts must be related by different kinds of necessity to the whole organism. Given that instrumental parts are governed by hypothetical necessity, the generative ones should be related by a different kind of necessity.[443] Although the only remaining kind of necessity is simple necessity it is not clear that this is the one intended here.[444]

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[442] However, the form that the explanations will take in the two cases, i.e. of simple and hypothetical necessity, may be similar. They will be of the form: 'because the end must come to be, such and such part must come to be.'

[443] One suggestion is that what can be regarded as the result of simple necessity at the level of individual living things, is the result of conditional necessity when considered at the level of the natural kind the thing belongs to.

[444] One possibility is that there are different stages in explanations relying on hypothetical necessity. So a part, p_1, might depend on the development of a further part, p_2, where p_2 is

Be that as it may it is clear that Aristotle believes that the relation between the end and that which is for its sake is realised in two different ways and that the Democretean account fails to distinguish in general the means-end relation between parts and whole, and in particular to distinguish between the two different ways this relation is exemplified. Therefore, Democritus cannot account for the different roles these parts play in the formation of the animal, nor can he explain the temporal order in the formation of a living thing. By contrast, an accurate account of the formation of a living thing has to capture these distinctions. For without them one cannot distinguish those parts or features that are parts of the substantial nature of organisms, nor the direction his explanations must take. Observing these distinctions constitutes the desideratum for an account of natural generation, and for a scientific theory laying out what these living things are:

> Now with those things that are immutable, the first principle is the essence; but as soon as we begin to deal with those things that come into being through a process of formation, we find there are several first principles –principles, however, of a different kind and not all of the same kind.[445] Among them the source whence the movement comes must be reckoned as one and that is why the heart is the first part which all blooded animals have, as I said at the beginning; in other animals it is the counterpart of the heart that is formed first. (II.6 742b34-743a1, Peck's tr.)

The source whence the movement comes is one of the first principles of the living thing. As a principle it is essential to the thing it is a principle of. As one of the principles it is only a part of that essence. So the instrumental-generative parts, such as the heart or its analogue,

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hypothetically necessary for p_1, while p_2 itself depends on the development of a further part, p_3 where p_3 is hypothetically necessary for p_2. This idea may be linked with the hierarchy of kinds of compositions in an organism which is given in *PA* II.1 646a13 ff.: (1) the composition of the four primary elements or *dunameis* (powers) out of the contrary qualities of hot and cold, moist and dry, (2) the composition of uniform parts, (3) the composition of the non-uniform parts. The compound bodies composed in each one of these stages serve as matter for compound bodies one level up, and therefore must be related to them by conditional necessity. (646b5-9) The composition of the animal itself supervenes as a fourth and final stage in generation.

[445] Here *arche* might be ranging over different, though overlapping lists of items. First, the four causes are *archai* (cf. *Met.* V.1 1013a16-17). So both the motive/efficient and the material cause are principles (716a5 ff. 762b2), linked, correspondingly with the male and female in animal generation. (716a6-7) But there is another list of possible candidates for *arche*: namely, 'that from which as an immanent part, a thing first come to be' (*Met.* V 1. 1013a4). In the case of a craft this is the basic part of the artifact being produced such as the keel of the vessel or the foundations of the house. In the case

are parts of the essence of living things, while there are other principles.[446] But not every part of the developed creature will be thought of as a part of that essence. Some parts, such as the upper portion of the body are considered as parts of the end of the generation process, while some parts, such as the lower portion of the body are considered as purely instrumental. This leads to the second problematic aspect mentioned above: how is the biologist supposed to draw the distinction between the different kinds of parts and therefore between those that are parts of the substantial nature and those that are not?

The temporal order of formation is one empirical test for drawing the distinction between different kinds of animal parts. But this is not the reason underlying the distinction which depends on the ranking of the parts with respect to the order of being, i.e. on relations of natural priority. These relations are introduced as the result of a teleological order. So the division of the parts will rest ultimately on teleological considerations. Some parts are for the sake of the whole as generative, some parts are for the sake of the whole as instrumental for its functions, while some parts constitute that for the sake of which the two previous kinds are, either by being generated by them or by being constitutive or controlling parts of the functions. So the priority relations ultimately depend on the teleological explanations that successfully capture the relations between the parts. A study of organisms must keep track of this model and divide its parts accordingly.

I shall turn to Aristotle's account of the activity of locomotion and the parts instrumental to it, in order to examine to what extent and how the above is model applied to the formulated explanations.

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of animal generation this is the heart, according to Empedocles, Democritus and Aristotle himself (cf. 766a35) or the head according to Plato (*Tim.* 44D) or some other part which has an equivalent role.

[446] First, since the instrumental-generative parts are relative to and naturally dependent on to what they generate, i.e. the developed organism, the developed creature must also be a principle. It is a principle as the end of the generative process, i.e. as a final cause. Second, the upper portion of the body as the pre-eminent part of this end. Third, the brain due to its counterbalancing power against the heat produced by the heart should be thought of as one of the essential part of living things.

4. The example of Locomotion

The activity of locomotion and the corresponding parts of living things are treated in *De Incessu Animalium*. Locomotive parts were classified as purely instrumental in *GA* II.6. An indication of this is that they are formed relatively late in the process of generation. But this is not the reason why they are instrumental. On the contrary, they are formed relatively late because they are for the sake of the activity of locomotion and there is no need for them to be formed before the organism is able to move itself.[447] So, first, there is no need for the organism to have fully formed locomotive parts before it has the power to move itself around. Secondly, nature aims at developing the most honorable parts first, by using the most honorable nourishment, while it develops the less honorable parts later on by using nourishment of a less honorable kind. So there is a teleological explanation of the late completion of the formation of the limbs based on the economy of nourishment and on the interrelation between the powers of the developing organism. Further, since locomotive parts are classified as purely instrumental they must be conditionally necessary and not parts of the essential nature of the kind in question. The teleological explanations accounting for the kind of locomotive parts offer grounds for dividing the features of a kind into essential and non-essential ones:

> An animal that is to stand erect must necessarily [a] be a biped and must also [b] have the superior parts of the body lighter, and those that lie under these heavier. Only if situated like this could it possibly carry itself easily. And so man, the only erect animal has legs longer and stouter relatively to the upper parts of his body than any other animal with legs. (710b5-10; Farquharson's tr.)

The reason why being biped belongs to humans is that humans stand erect. Standing erect is something that belongs to the essence while bipedity is an instrumental feature. Moving erect necessitates conditions [a] and [b] above. So the explanation seems equivalent to the following counter-factual:

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[447] See the principle of formation, (PF), p.247 above.

(C1) If man was not biped and had not the superior parts of the body lighter, then it could not be an erect animal.

Still (C1) is incomplete unless something is added in its consequent, for [a] & [b] are necessary because it is only in this way that humans can carry themselves around easily. (C1) could be modified thus:

(C1*) If man was not biped and had not the superior parts of the body lighter, then it could not be an erect animal that would carry itself easily.

This extra condition, though not explicit in the passage, is assumed at the outset of the discussion in the *IA*. Aristotle introduces two principles used widely in the scientific investigations of nature: 'of these one is that (NP)[448] nature creates nothing without a purpose but (NP*) always the best possible in each kind of living creature by reference to its essential constitution. Accordingly if one way is better than another that is the way of nature.'[449] (*IA* 2. 704b12-7) The claim that humans have parts that will allow them to carry themselves around *easily* is an application of this principle. Given the essential constitution of humans, being an erect being that has an inner source of movement, nature creates it in such a way that it will make it easier for it to move. The explanation given for the fact that snakes are limb-less, at *IA* 708a9-20, is similar in structure. It is grounded on the two following principles:

(1) (NP*) Nature regards what is the best possible for each individual [kind] preserving the peculiar substance of each and its essence, and
(2) No sanguineous animal can move itself at more than four points.

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[448] I follow Lennox's abbreviation of the above principle here. Lennox abbreviates as (NP) the weaker principle *nature does nothing in vain*, while (NP*) is reserved for the stronger principle quoted above. [Lennox (2001b:206-7)] For versions of the weaker claim see *PA* III.1 661b23; IV.11 691b4; 12694a15. Another general principle, related to the strong claim, is that nature assigns to each part one function only for this is better. (*Pol.* I.2 1252b1) However, explanations that reveal a multiple use or function for some parts imply some qualification of this principle. (*PA* II.16 659b36; III.1 62a16-24)

[449] *Nature* here need not refer to anything other than the natures characteristic of the different biological kinds. Although it is a matter of controversy whether the natures of other entities in the natural world, such as the natures of inorganic stuffs, must be included in the scope of the above principles, the texts examined here cannot be taken as suggesting anything positive in that respect.

By applying the two principles one can form a proof that snakes must be limb-less.[450] Two elements of the substantial nature of snakes are mentioned: their being sanguineous and their length being out of proportion with the rest of their dimensions. Given (2), they cannot move themselves at more than four points, since moving at more than four points will be a violation of their sanguineous nature, and thus it would violate (1). So if snakes had limbs they should have no more than four.[451] If so then their movement would be slow, given the length of their body, and unprofitable to the animal and snakes would be practically stationary. The generation of an animal that would be practically stationary would contradict (1) according to which each animal must be endowed with the necessary parts that would preserve its substantial nature, or in this case facilitate its locomotion in the best possible way. The only alternative is for snakes to be limb-less. So the explanation why snakes are limb-less has two components: (I) the locomotive parts should be such as to guarantee movement in the best possible way, and (II) this must be done in such a way that the nature of the animal is preserved. The reference to nature in (II) is to the substantial nature of the kind, which delimits the possibilities constraint (I) ranges over.[452] It must be noted that the reference to the bodily proportions of snakes is not a clear reference to some formal element of the kind (though it refers to its shape), at least if the form of the biological kind is understood strictly as the soul of the corresponding body. So the reference to substantial nature in (II) implies either that, apart from formal elements, material aspects are included in that nature, or that this nature is not conceived in abstraction from the matter in which it is embodied.[453]

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[450] In *PA* IV.13 696a5-9, there is a similar explanation of the fact that sea-eels have no fins. They, like snakes, move by bending 'using the water as snakes use the land.'

[451] More accurately they would have either two or four. For the reason why animals must have an even number of feet. (See 708a22 ff.; cf. chapter 6 706b29-707a5). For the relation between being sanguineous and movement at four points, at most, *IA* 6 707a17-21 and especially *IA* 7.

[452] The above explanation could be formulated in terms of a counter-factual claim similar to (C1*) above: (C2*) If the kind snake was not footless, then it could not be an animal whose length is out of proportion that would move in the best possible way.

[453] I will come back to this in the next section.

In general, in order to prove that a differentia, *d*, involved in an activity or function, *f*, is a necessary characteristic of the nature *N* of kind *k*, one needs two premises: one appealing to the substantial nature, N_k, which includes *f*; and one appealing to the principle that N_k does best for *f*, i.e. to some version of the (NP*) principle. So some version of (NP*) must be built into the *explanans* of the explanation (or the consequent of the counter-factual). Now let us see what are the limits that constrain this principle and what are the possibilities over which it ranges.

There are at least two ways of understanding the way (NP*) operates. It may be suggested that (NP*) is an external constraint imposed by nature as a kind of designer of animal kinds or something equivalent. But there is no positive evidence that nature for Aristotle is thus designed.[454] Alternatively, (NP*) preserves nature N_k by operating within the limits set up by N_k. In that case there must be specific forms of (NP*) each one of which will correspond to the nature of a kind. The explanation of snakes' limbless-ness offers positive evidence for this reading. (NP*) governs the way the differentia of snakes with respect to movement is determined given the nature of snakes. It does not determine the way the kind possesses this nature as opposed to any other. The nature of snakes, N_{snakes}, is outside the scope of (NP*). So (NP*) in the above explanation operates within these limits.[455] The nature of the kind is the nature which is the subject in (NP*). The next question is what are the possibilities over which the principle ranges.

According to some commentators the range of possibilities is restricted by the generic features of the more extensive kind to which the animal kind belongs.[456] Let us try to specify

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[454] Unless the relevant metaphors personifying nature are taken literally. For an argument for the claim that these metaphors do not import a *Demiurgic Nature* or a *Cosmic Nature* see Lennox (2001b:183-4; 187ff.).

[455] Lennox argues for this view: 'since what is best is relative to the being of each kind, explanatory appeals to the principle that a feature is as it is because it is better would seem to depend on prior knowledge of the substantial being of each kind of animal.' (2001b:207)

[456] Lennox (200b1:207): 'each formal nature does what is best, within the range of possibilities represented by its wider kind(s). Among these 'generic' restrictions are those related to the kinds and quantities of materials the formal nature is provided to work with in achieving the good.'

this claim further. In the snakes' example there are three possibilities: snakes could have been (a) four-limbed or (b) two-limbed, or (c) limb-less. What are the generic features that determine the range of possibilities in this way? First, the most general constraint must be equivalent to the claim that animals have the ability for local movement and thus need parts that would facilitate this movement in the best possible way. This is a characteristic of the wider kind to which locomotion belongs. Aristotle must be making such an assumption in arguing that every footed animal has necessarily an even number of feet (708a21 ff.).[457] (NP*) is already operative at this level. Still, this restriction, sc. an even number of feet, does not suffice for deriving the above list of possibilities. Further constraints are introduced, such that snakes being sanguineous animals can move at four points (at most). (704a10-12, 707a19-21) Placing the kind snake inside the genus of sanguineous animals, restricts the possible number of limbs to four, at most. The two constraints, jointly, suffice to set out the possibilities for snakes. As a result their nature has to be arranged according to one of possibilities (a) to (c) above. Again (c) is the best possible way the locomotive capacity of the generic common nature could be realized for snakes. And this explains why it is the actual one. So some form of (NP*) is operative at this level, i.e. the level of the kind *snake*.

This suggests that perhaps there is no bottom level at which the principle is not operative, other than that of material constraints that result from the particular natures of the material available for the formation of the organism. Once introduced at the most general level the principle ranges over any other more specific set of possibilities. At each level, however, there are elements, properties or parts that are placed outside the scope of the operator, as part of the nature that must be preserved and thus must be included in the

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[457] Aristotle argues from the premise (I) that animals are either better able to progress with even feet or cannot otherwise progress at all to the conclusion (II) that animals should have an even number of feet. (II) follows from (I) only if there is a principle such as (NP*) necessitating that what is best will become actual.

explanans of the explanation.[458] Therefore let us look at what kind of features of animal kinds are taken as constraints of the nature of the kinds explained in the *IA* and are treated as explanatory of further features of those kinds. For this will also reveal what elements are posited inside the substantial natures of those kinds.

5. Locomotive parts and explanation

Explanations with respect to locomotive parts are found both in *PA* and *IA*. Since the latter work is devoted to the explanation of these parts I will focus on it, and I will refer occasionally to some of the evidence found in the *PA* books where this is relevant. The two most often cited constraints in the explanations of differentiae of locomotive parts of animals is their being sanguineous or not, and the environment in which the natural kind lives (e.g. dry land or water) or its mode of life.[459]

A general and widely used connection in explanations of locomotive differentiae is that between being blooded and moving at no more than four points. In *IA* 707a17-24 we are told that *almost all* sanguineous animal move at four points, and that all animals that move at four points (at most) must be sanguineous. (see also 709b20-23) The reason why of this connection is not clear. The subsequent lines point to a test which helps drawing the line between non-sanguineous polypods on the one hand and sanguineous quadruped or biped creatures on the other. The former can survive and continue to move if divided while the latter cannot. (707a24-31) The reason is that polypods, by contrast to sanguineous animals,

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[458] E.g. in the case of the genus animal its locomotive capacity, in the genus of sanguineous animals movement at four points at most, or in the kind snake its shape. Similarly in Gotthelf's schema concerning the axiomatic structure of Aristotle's biological explanation the teleological principles that govern these explanations are placed outside the tight structure relating parts as constituting explanatory factors for other parts: 'I have claimed that there are at least two sorts of teleological principle involved, one which asserts that formal natures are ends and one which asserts that those natures operate for the best. Since the first of these principles is pervasive and the second quite frequent, and since they do not affect the lay out of the *terms* of the explanation, but the manner of their *connection*, I place them in a horizontal box at the bottom, to indicate their role in underwriting the explanations, without indication as to how exactly they do.' (1997b:89)

[459] Further, facts about the generation process characteristic of a kind are also used in some explanations. But these explanations could be nested under the rubric of explanations with respect to the mode of life.

are more like a combination of different living things. So although being sanguineous may offer a safe criterion for drawing this distinction, it is not the explanatory factor that ultimately explains why sanguineous kinds move at four points.

A passage from the *PA* may suggest such an explanation. According to *PA* IV.6 682b1-4 the many limbs of insects compensate for their slow and cold nature, by allowing them to be more rapid. But they also have many feet because they have many origins.[460] It is not very clear whether coldness or a plurality of origins is a stronger factor for their many feet. Still what is clear is that one reason they have many insections and a set of appendages for each one of them is that they possess many origins. Further, there is also one other reason for their being insected: in this way they can keep themselves alive. Those that have length do so by curling up to avoid harm, while those that do not have length do so by rolling themselves up and increasing their hardness by drawing their sections together. (IV.6 682b22-5) So one explanation relates their many origins, as many as their insections, to preservation, i.e. to the final cause. This explanation suggests a necessary connection between the origin of the organism and a limit in the size of the body it can be the origin of, as well as a maximal number of appendages it can exercise its controlling power upon. This connection is also implied by the thought, expressed elsewhere in the *PA*, that the origin of the animal's body is placed in the middle of this necessary body. (III.5 665b15-23) The origin is placed thus because this is the most honorable position, but also because the middle of a body is a unique point equally distanced and accessible from all directions alike. (III.5 666a15) In fact this may be the reason why the center of the body is considered to be more honorable. The origin must be placed in the middle of the body and in almost equal distances from the more remote bodily parts, including its appendages, so that it can exert the

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[460] The multiplicity of origins in insects is introduced in *PA* III.5 682a1-7. Their origins are one in actuality, but more than one in potentiality. According to Lennox it is not clear whether coldness of insects or their having multiple origins is explanatorily prior to their large number of feet. (2001a:305)

necessary power. If so it is possible for insected animals, since they have a plurality of origins, to possess a corresponding number of appendages.[461]

Now, let us suppose that sanguineous animals had more than four appendages. If so there would be no such central location in their body where their origin could be appropriately placed. This would be contrary to their nature according to which the origin must be able to exercise its control in the most effective way. So their possessing more than four appendages would constitute a violation of the (NP*) principle. Although this explanation is not in the text it makes sense of the connection between being sanguineous and having no more than four appendages. Blood explains moving at four points because it implies possessing a heart, i.e. one and only one origin for the animal which must be placed at equal distances from the other parts of the body. One origin can support movement if it is located in equal distances from the appendages, and no body with more than four such appendages could satisfy this principle. So moving in more than four points would constitute a violation of the substantial nature of a sanguineous organism.

With respect to environmental conditions things are relatively clearer. The environment in which organisms live, produce their young and get their nourishment constrains the kind of locomotive parts they need to possess in order to carry themselves in this environment. In the *IA* environmental factors are exploited in at least four places. The most general statement concerns the reason why fish do not have feet in addition to having fins, while birds do have feet on top of having two wings. The reason is that the latter live on dry land, hence they need feet, while the former, living in water, do not.[462] So placing the kind in question under the genus of land-dwellers, water-animals or winged-animals can

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[461] The teleological explanation relates the origin of the organism to a certain position in its body from which it can sufficiently exercise its control over the latter. The origin is placed in the center of their body and at almost equal lengths from the appendages. Still these points of origin exist only in potentially, while only one of them is in full actuality and this may explain the low degree of warmth in these organisms. Against the above suggestion, in the case of snakes a single origin suffices to control an elongated body.

[462] *IA* 714a20-b2; *PA* IV.13 695b16-27.

explain, at least partly, its locomotive parts by providing a reason for possessing these organs.

It is interesting that, although it seems that the direction of explanation and priority could go either way, the text here suggests that the direction goes from the environment to the locomotive parts. Being a water dweller must be explanatorily more basic than and prior to having fins with respect to the substantial nature of the kind. What determines this priority?

The priority most probably depends on the more pervasive character of the water-dwelling character of fish in explanations of other characteristics (when contrasted to their possessing fins). The environment constrains the mode of life of the animal kind in question and thus constitutes a more basic explanatory factor for its other characteristics. The mode of life is one of the basic sources for differentiating properties between animal kinds.[463] The mode of life is differentiated with respect to criteria that have to do with the way organisms keep the right proportion of heat, by cooling their body, or the kind of nourishment necessary for them. (487a16 ff.) So perhaps the priority of mode of life over locomotion has to do with, or is equivalent with, the priority which some functions such as nutrition have over the function of locomotion.

Other explanations of locomotive parts with respect to environmental features display the same order of direction. At *IA* 713a16-25 we are told that oviparous quadrupeds that live in holes have their legs attached obliquely as their whole body sprawls over the ground, and can bend them obliquely (e.g. crocodiles, lizards, spotted lizards, freshwater tortoises, and

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[463] In *HA* I.1 487a10-11 mode of life, activities, dispositions –together with animal parts- are listed as the respects in which differences among animal kinds are collected. Some passages emphasize the connection between way of life and way of locomotion. In *PA* IV.12 694b12-3 the long-leggedness of some birds is explained by the fact that they have a marsh dwelling way of life. In *PA* IV.12 691a24-5, sharpness of sight belongs to birds because of the way of life which is identified with their being fliers. The way of life is also referred to in explaining needs for different kinds of nourishment. The latter imply corresponding differences with respect to the necessary organs for assisting the consumption of this nourishment (e.g. the explanation of the length of beaks of different kinds of birds in IV.12 693a10-2; the explanation of the length of neck at IV.12 693a3-4).

turtles). There is a double explanation of this, the reason being that it is useful (a) for ease in creeping into holes, and (b) for sitting upon their eggs and guarding them.[464] The next passage at 713b9-11 offers a similar explanation for the appendages of polypod animal kinds that live in holes. Finally, at 714a8-11 web-footed birds living in the water, although they are biped on account of having lungs, they also have their feet webbed since they live in water. All four examples point to the importance of environmental conditions for the possession of specific kinds of appendages.

More interestingly Aristotle offers some explanations of appendages of animal kinds in terms of their manner of generating their offspring (although these explanations could be classified under the rubric of manner of life). Their appendages are such that they facilitate or at least do not complicate the generative process characteristic of the kind. There are at least two such explanations in the *IA*. The first one comes at 711b29-32 where Aristotle explains why the two hind legs of viviparous quadrupeds bend backwards. Part of the explanation is that it is necessary or at least best for their legs to bend backwards when they are suckling the young because thus it is easier to keep them under them.[465] The second was the aforementioned explanation concerning appendages of oviparous quadrupeds that live in holes. Their legs facilitate their sitting upon their eggs and guarding them. (713a16-25) The reference to some profitable results, in the above explanations, relating to breeding do not carry the main explanatory force of explaining the possession of a particular kind of appendages, since the main explanatory factor has to do with facilitating locomotion in a particular environment. The explanations from breeding rather cite some additional

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[464] Furthermore, oviparous quadrupeds that live in holes, as they are splayed outwards, must of necessity tuck in their thighs and put them under them in order to achieve the lifting of the whole body. The result is that the only way they can bend their limbs is outwards.

[465] The claim that this is necessary or at least for the best reminds of the much debated passage in *PA* I.1 640a33 ff. where Aristotle refers to three possible manners of explaining animal parts as being (a) conditionally necessary (b) unqualifiedly necessary or (c) for the best. Here he seems vacillating between (b) and (c). See Lennox (2000a:*ad loc.*) for a summary of the interpretations of this controversial passage. The main problem is the contrast between senses (a) and (b), if indeed they are different. As Lennox points out even if explanations in (a) and (b) differ with respect to their content they do not need to be different with respect to their structure.

beneficial results of possessing the specific kinds of appendages. Still the fact that Aristotle mentions them here emphasises the importance of the generative process as a defining activity of natural kinds.

Another set of explanations of locomotive parts refers to the appropriate formation of some bodily parts, other than the appendages themselves, so as to facilitate locomotion. So the lightness of the upper body in humans is explained by their erect position. Given that they must be able to walk erect they must have the upper body lighter than the lower. (710b5-11) This explanation must be compared with the *GA*'s statement that the upper portion of the body being more honorable is formed first while the lower parts being of an auxiliary nature and of a lesser value they are formed later. The impression from the *GA* is that the structure, length, and shape of the appendages will depend on the corresponding features of the upper body. Whatever the upper body of the animal, nature will manufacture the appropriate appendages for it. This claim, although not falsified by the *IA* explanation, is qualified. For according to the *IA* the structure, length and weight of the upper body, as well as the appendages, are constrained by the manner of locomotion characteristic of the kind. The *explanans* is moved one level back, as it were, and the *explanandum* now includes both the shape of the upper and lower body.

This thought is strengthened by two more examples where the proportion between the parts of the body is taken into account in explaining the parts.[466] These are the cases of flying insects (710a10-18) which fly very slowly and birds which are at the opposite pole of flying, i.e. birds that are swift fliers. (710a24 ff.) The latter have swiftness of wing because this is useful to their mode of life. Again here mode of life stands for conditions that relate to the preservation of the substantial nature of the animal, i.e. with constraints that relate to nutrition and protection. But in order to be able to fly swiftly the rest of their bodily

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[466] See also *PA* II.16 659b7-10 where the locomotive parts of birds impose constraints on the weight and shape of the upper body as well as the head of the organism, which normally are considered to be a part of the substantial nature.

structure must be in harmony with their peculiar movement, and so they have small head, slight neck, strong and acute breastbone. Here almost the whole structure, size and weight of the body is explained as being for the sake of locomotion. Finally, in the case of insects we have another piece of evidence for the importance of the activity of locomotion. Insects are poor fliers because their wings are disproportional to the bulk of the body. It is not clear whether the failure consists in that they have small and weak wings or heavy and bulky body. It is more likely that nature's failure consists in creating a well-proportioned body. In that case, we have another example where both the upper and lower body are explained by the need for appropriate means of locomotion. And this independently of whether the upper body, being prior to the lower body, can serve as the *explanans* of the latter.[467]

Finally there is the curious explanation of the locomotive parts of crabs. (712b13-21) Crabs are the only living things moving obliquely, or at least seeming to do so. For Aristotle adds that forwards and backwards is a distinction relative to the line of vision. Since crabs move obliquely nature made their eyes so as to conform to their limbs. So, perhaps crabs do not move obliquely after all. What is curious here is that the means for sight, and a pre-eminent part of the upper and more honorable portion of the animal's body is constrained by the nature of an auxiliary part (at least as far as their positioning is concerned). This is a solitary example and perhaps not much can hang on it. Still it exemplifies the explanatory lengths at which Aristotle is willing to go in order to give justifications for the formation of animal parts by their substantial nature. For in that case his argument aims at concluding that the movement of crabs is not after all oblique and irregular, and thus it does not impede

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[467] Similarly in the *PA* there are passages implying that nature aims at striking some balance between upper and lower body, instead of just aiming at producing the appropriate kind of lower parts, since the upper part is something more or less given. So in *PA* IV.9 685a25-6 nature takes from the upper part of octopuses and 'adds to the length of the feet, while in the cuttlefish and squid, by taking from the feet, the body increases.' In *PA* II.12 692b19-693a1 the longitude of the neck depends on the longitude of the legs. Nature gives a short neck to short legged creatures while to long-legged creatures a long one, so as to facilitate them in eating their food off the ground. Finally *PA* II.10 686b6-8 refers to the proportion between lower and upper parts in human beings. Their nature strikes this balance by taking what is bodily from the upper parts and adding it to the lower ones. (*PA* II.10

the exercise of their nutritive capacity. To that end he is not unwilling of placing less honorable parts in the *explanans* of the explanation of more honorable ones, or parts that he would standardly consider as having a better claim for being included in the substantial nature of the kind.

To summarize the above set of explanations with respect to the activity of locomotion in animal kinds and the corresponding parts, they rely on four main kinds of features that serve as parts of the explanations: (a) certain activities that characterise the substantial natures of the kinds in question (the activities themselves are often related by relations of natural priority), (b) the environment in which living things evolve, (c) certain types of features or parts such as the bulk and weight of the upper part of the body as well as its proportion to the lower parts, and (d) the available material for the formation of these features. Features under (a) and (b) are closely related.[468] The activities that constitute the substantial nature of the organism are not understood independently of the constraints imposed by the environmental conditions. So for instance the activity of nutrition and the corresponding organs depend on these conditions. Finally, at times, necessary arrangements or parts formed for the optimal exercise of one activity constrain the arrangements or parts formed for the exercise of a different one.[469]

But there is more to the substantial natures of organisms than their activities of nutrition, generation, locomotion and perception. Features under (c) are explicitly included in these natures, at least in contexts where the features in question are taken as explanatorily more basic with respect to other further properties or parts of these organisms. Features under (d) are also employed in some explanations, e.g. the explanation of how nature strikes

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689b12-3) the balance of the dwarf-like quadrupeds is reached by managing the material in the opposite direction. (*PA* II.10 689b25-6)

[468] This is also evident from the close connection between elements in (a) and (b) above and the manner of life characteristic of each kind. The manner of life is specified with respect to the environment the organism lives in while the activities are constitutive of the manner of life.

the right proportion between upper and lower body so as to facilitate locomotion. However, no purely material determinations are included in the substantial nature. Still items under (c) include references to the material natures of the kind. They are not pure formal characteristics, but they include some reference to material properties of the kind. Thus the corresponding substantial nature must include some material aspects. For instance, blood restricts the ways in which sanguineous organisms move. However, there is no obvious explanation relying on the material properties of blood as such. The explanation must be relying on some connection between blood and the principle of the organism, namely the heart. Sanguineous animals have blood as an instrument of the heart originating the necessary movements that constitutes the exercise of the soul-capacities of the organism.[470] If this is so then although material aspects will enter into the account of substantial natures of living things they are determined by the formal nature of the corresponding kinds.

6. Explanation and essence

The above examples are suggestive of some more general points regarding the direction Aristotle takes in giving explanations of biological kinds. They suggest some criteria underlying the division between what is and what is not part of the substantial nature of organisms.

First, the defining characteristics of the kind are elements that could appear as premises in syllogisms proving why the kind possesses certain parts that appear in the conclusions of these syllogisms. The terms in the conclusion could be differentiae, such as the locomotive differentiae explained in *IA*, the possession of which the biologist aims at explaining. The substantial nature is presupposed for the possession of these parts and it

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[469] The only activity used as explanatorily more basic without itself being at times explained by others is that of generation. The examples considered above may indicate some priority here but they cannot warrant any stronger conclusion.

[470] Equally the size of the animal is not just a material determination of the organism. Its size is determined by certain proportions worked out by the nature of that organism; proportions that will allow self-maintenance and persistence of the exercising of its activities in its environment.

forms part of the *explanans*. But the *explanans* includes the principle that nature, most probably understood as the particular substantial nature involved in the explanation, works for the best. The explanations are teleological since the parts are usually explained as the optimal solution given a set of possibilities constrained by the elements of the substantial nature which are part of the *explanans*.

The second point that can be discerned from the above examples is that the elements of the substantial nature, included as parts of it in virtue of their explanatory role, may belong either to the generic nature, to lower-level genera or to lowest-level specific kinds. Therefore elements at different levels of generality can play a role in determining the differentiae of the lowest-level kinds.[471] The *aitiological* explanation must be at the appropriate level of generality which is not necessarily the level of the lowest level kinds. There is priority of, at least some, generic characteristics over specific ones. This also suggests that division is important in placing the kinds under the appropriate generic kind through which the possession of certain essential features can be explained. So the items included in the definition of the substantial nature might be at varying levels of generality. For instance, being sanguineous is part of the *explanans* of why all kinds in the class of sanguineous organisms have at most four appendages. The explanation must refer to the common nature of samguineous animals.[472] So, there are generic constraints restricting the possibilities with respect to animal parts. The nature of the wider genera under which the

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[471] Gotthelf (1985:49).

[472] Further, the fact that a kind falls under one of the genera of land-dweller/water-dweller/flier plays a determining role on the kind of appendages it will come to possess. (*PA* I.2 642b5 ff.) This is controversial, since, as Lennox points out, there is a general problem with placing a characteristic at this level of generality inside the account of the substantial being: this violates the principle ...of division at 643a1-5 (which uses being blooded as an example), that a feature in the substantial nature of an animal cannot be common to any other (sort of) animal. (2001a:332) The objection can be blocked if, as Lennox notes, the common element can be further differentiated. This does not imply that the explanations must be construed at the level of these differentiations. Hence the answer to the objection does not imply that every explanation must be construed at the level of lowest level kinds. Explanations will be formulated at the appropriate level of generality, i.e. at the level where the feature belongs *first*.

kind falls determines the formation of specific parts in organisms of that kind.[473] Generic features delimit the possibilities of variation among the kinds classified under them, thus constraining the substantial natures of these kinds. This counts against the view that there are simple essences at the level of lowest level kinds that explain all other necessary features of those kinds.

Even with the above constraints in place more is needed for determining the method for delimiting what is to count as part of the essential or substantial nature of each animal kind with more precision. There are at least two general questions that should be addressed in that respect. They can be put simply thus. At first glance, the explanations of the capacities, the corresponding parts and the other natural properties of living things considered above have the from of a series of terms e_1, e_2,... e_n, where each member of the series is explained by one (or more) of the terms that come before it in the series and serves as explanatory for the term(s) that follow it.[474] The questions are, first, where is the line to be drawn between what is explanatory as a part of the substantial nature of the living thing and what is not? Could we do so by taking, say, only features that are explicitly said to be parts of that nature? Secondly is it possible to pick out a first member of such a series?

The situation is more complicated than the phrasing suggests, especially in relation to the first question, for the explanatory network in the *IA* and *PA* is much more complex than the structure implied by the above schema. Although some explanations when isolated may

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[473] There are other examples where a common generic nature constitutes the right level at which the constraints of the substantial nature are found: (a) the common nature of all breathers collects all 'these uses together [sc. breathing, protection nourishing] in one, producing a differentiation of this part [sc. mouth] for the differences of its operations.' (*PA* III.1 662a16-30; 662a22-4) (b) the common nature of horn bearing animals determines the fact that female deer do not have two rows of teeth. This is possible for female deer, since they, by contrast to the male, do not have horns. (*PA* III.2 664a3-8) The surplus could have been used for forming a second row of teeth. However, this is impossible since none of the horn-bearing animals have upper front teeth, and if female deer did they would fall outside the genus of horn-bearing animals. (By contrast Crubellier & Pellegrin (2003: 301) argue that this is an example where natural necessity imposes herself on the finality of nature) Finally, (c) the common nature of blooded but non live-bearing animals 'makes a transition by small steps' from the nature of blooded live-bearing animals with respect to the quality of the bones characteristic of the kinds falling under it. (*PA* II.9 655a17ff.)

present this structure, in general there are (I) different kinds of essential features at different levels of generality, which often in combination explain further essential features, then, (II), premises concerning the material aspects of the living organism which often instead of being the *explanandum* form part of the *explanans*, and, finally (III), teleological principles.[475] But even then the difficulty persists. Suppose we had a clear axiomatic structure of all the explanatory relations between the terms that appear in the explanations of the features of the lowest level kind of a wider kind, and that the terms are ordered in such way that all explanations flow from a few basic items. Suppose also that what is to count as part of the substantial nature depends on whether it is explanatory of further natural features. Then it is not clear at which point one can decide that something is not part of the substantial nature. Explanations will move from one natural feature to the next (perhaps all the way down to the four basic elements), but there will be no clear dividing line between what is and what is not part of the substantial nature. Then, either a feature will not be included in that nature only when it is not explanatory of any further natural feature, and as a result the vast majority of natural features are parts of the substantial nature. Or it could be that only what is not explained by any further term is included in it, so that there would be very few first principles for which there will be no prior explanatory term, and the substantial nature will include only them. The explanations considered above point to the opposite direction. For there is a variety of features which although they are explainable, partly or not, by appealing to more basic facts about the natures of organisms, they are still considered as parts of its substantial nature.[476]

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[474] This schema oversimplifies matters. A more accurate picture of the network of explanatory premises is given by Gotthelf in (1997b:87-89).

[475] Here I follow Gotthelf. (1997b:91) It is not the case that there is a neat division or diagram where elements of the substantial nature are concentrated on one side of the explanatory diagram while those that are not follow from them and are on the other side, thus clearly demarcated from them.

[476] The difficulty can be illustrated by the case of locomotive parts. The *GA* seem to suggest that they are auxiliary parts which should not be included in the substantial nature of a kind. Still Aristotle constantly uses examples of locomotive-differentiae as parts of the essence. (*Met.* VII.12) Moreover, in some of the explanations considered above, locomotive parts constrain and explain parts which

One plausible suggestion is not to read the references to substantial nature rigidly. There might be functions of the organism such as nutrition that are more basic for its survival and therefore considered as part of its 'core' substantial nature. To this extent they constrain the formation of other kinds of parts which do not immediately relate to those vital functions. Locomotive parts, for instance, may fall in this latter class. They may not be vital for the organism in the way nutrition and its organs are. Still they have a crucial role to play with respect to the exercise of the core functions. So although they may not be parts of the 'core' substantial nature, they might be part of this nature more widely construed. It may be suggested then that although certain characteristics are more basic than others with regard to the being of the kind, there are wider and more narrow ways of construing the substantial nature of a kind, as well as a gradation of such conceptions of that nature.

One way to fill in the details of the above suggestion is by means of something equivalent to the survivability criterion. There are features or parts of living things that are necessary to them in the senses that for any specimen of the kind loss of any of these parts will entail its annihilation.[477] The animal cannot survive any privation or hindrance with respect to them. Indeed there is no privative state with respect to those features, since deprivation with respect to any of those features entails annihilation. On the other hand, there are features, e.g. locomotive parts, which are purely instrumental and thus no part of the substantial nature (at least narrowly construed). For in their case a specimen can survive their loss.[478] So characteristics included in the narrow understanding are more basic and

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would normally be placed in the substantial nature. If so it would be odd not to include locomotive parts in the account of that nature.

[477] E.g. generic features such as being sanguineous, or a land-dweller etc. If neither of these features is truly predicated of a particular animal then nor can the specific kind be truly predicated of it.

[478] For instance, although animals have by nature an even number of limbs, they can survive the loss of any of those limbs, and, therefore, they can survive as the same kind of animals with an odd number of limbs. (708b5 ff.) This means a serious compromise of their natural capacity for locomotion. But what is important is that privation, or hindrance of their nature in that respect does not entail annihilation. Animals with an even number of feet can progress but do not properly speaking walk. (*IA* 708b10-11) They still are living things of their kind, although they are deprived

constitute *strong natural features* (SNF) without which an entity cannot survive as a specimen of its kind. Characteristics included in the wider understanding will be derivative, given SNF, or *weaker natural features* (WNF).

Although some version of the survivability criterion may be implicit in regarding some features as essential, there seem to be additional determinations,[479] implied by the fact that Aristotle's explanations rely on teleological priorities between the features or parts of living things. If we take the set of features whose loss an organism cannot survive, what will determine whether all or some of them form part of the substantial nature or not are teleological explanations grounding priority relations between them, and not survivability. Teleological explanation therefore suggests a division between stronger natural features, close to the core of the substantial nature and weaker or more remote ones. By contrast, survivability cannot help in distinguishing features that are unqualifiedly necessary to an organism and therefore prior from what belongs by conditional necessity to it.[480] What grounds this distinction must be the feature that grounds teleology in the account of generation and functioning of living things. It is because the substantial nature exists as an end that one can divide what is essential from what is merely necessary in that way. So a primary element that will be included in the substantial nature is that which makes it an end. The element that implants this end-directedness of organisms, i.e. the generative/nutritive

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from performing a particular activity. According to *PA* III.4 665b23, limbs are not among the parts necessary for life. Hence, life can be maintained even if these parts are removed.

[479] In that respect the criterion will be very different from any modern essentialist version of the survivability criterion. In a modern account survivability, often, is a necessary and sufficient condition for essential properties, and since no other criterion is evoked there is no further discrimination between the properties of an entity. By contrast in Aristotle there may be a gradation between the necessary properties of a subject depending on teleological considerations. For instance, many of the material properties of a living organism pass the survivability criterion, yet they are not normally conceived as parts of the substantial nature of the kind.

[480] Equally the parts of an organism that it can do without are less significant not because they are contingent but because they are instrumental. It is this teleological relation which can explain their contingency.

capacity of organisms, will be at the bottom level of the teleological explanation and at the core of the substantial nature.[481]

As we saw earlier the temporal order of the formation of the parts may indicate a hierarchy between the properties of a living thing and more crucially it may indicate what the first member of such an hierarchical structure of terms is. But the order of formation is neither the reason of such a structure nor always safe as a criterion for deducing what the real structure is. A teleological explanation reveals where explanation begins as well as its order. In the case of appendages, the parts are considered with respect to a function they serve, i.e. locomotion. The function is explanatorily prior to the parts serving it, since nature makes the organs for the function and not the function for the organs. (*PA* IV. 12 694b14-5) So the function of the parts represents the first constraint, and a first explanatory factor in formulating an explanation of these parts. Priority relations of a similar kind may hold between functions or soul-capacities themselves.[482] And the most generic and basic capacity is the generative/nutritive one. It is the exercise of this capacity which is responsible for the activity of life.[483] Further, the definition of life through the nutritive capacity of living things, suggests that even where there is no functional explanation for the priority relation between certain parts the mere fact that they are formed through the activity of a teleologically functioning capacity implies that there is the relevant priority.[484] This

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[481] This also suggests an answer in the second question addressed above (namely where does explanation and substantial nature start from). I take this suggestion to be close to Gotthelf's proposal that explanations which move from an animal's essential nature to what is necessary for the animal presuppose the *postulation of these formal natures as ends*. (1997b:90) Formal natures of living organisms exist as ends in virtue of the soul-faculty of generation/nutrition.

[482] In *PA* I.5 645b13-33 Aristotle argues for the priority of some actions/functions of an organism over others, the former being the end of the latter. The parts performing those functions are related in a similar way.

[483] This power constitutes the basis for the life-activity of the organism. Other natural activities of the organism may stand as matter to this central activity as their form. See Broadie (1982a:242) for an analysis of the agent/patient relation in organisms in terms of the distinction between activities which constitute the behavioural form and activities that constitute the behavioural matter of that organism.

[484] Of course, it may be that for some characteristics of the substantial nature of a kind (such as the size of the animal) which constrain the explanation of other parts, no obvious teleological explanation of their priority is forthcoming. The temporal order of the formation of parts offers only

illustrates the central role of the process of nutrition/generation in grounding teleology in natural living things. The first term in the explanation of organisms is irreducibly teleological. The primary bodily organ through which this is effected is the heart (or its analogue in non-sanguineous animals).

7. Conclusion: Narrow and wide conceptions of substantial nature

The evidence from *IA* could be taken as suggestive of a division between stronger and weaker conceptions of the substantial nature of a natural kind. Survivability may be one consideration that helps grounding this distinction, but there are reasons against taking survivability as a sufficient criterion for drawing the distinction between narrower and wider conceptions of substantial nature. Rather teleological considerations are determining the priorities between the parts of living things.

This suggestion concerning narrower and wider conceptions of the nature of a kind is also compatible with the threefold division of animal parts in the *GA* II.6,[485] which depends on teleological connections between them. The account suggests that there is a series of features related by instrumental relations, rather than an absolute dividing line between purely instrumental features and features that are parts of the end. At the one end there is the whole living thing while at the opposite end there are purely instrumental stuff(s). Plausibly the series is extendable all the way down to the four inorganic elements whose presence, though not their activity, in the organism is conditionally necessitated. But there is no point at which the series of teleological relations could divide sharply between two kinds of parts.

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indications of the teleological order of nature. However, since this temporal order relies on the way nature manages the nourishment temporal priority is a safe indicator of the activity of the substantial nature of the animal.

[485] One indication that the two are compatible is the vagueness in the way both the three-fold distinction between animal parts, and the proposed division between wider and narrower conceptions of the nature of a living thing are drawn. With respect to the former, generative parts are not only means to an end but also parts of the end. So although in one context they may be considered as instrumental, in other contexts their being parts of the end might be more significant, as e.g. when the instrumentality of other parts is explained through them. Secondly, although Aristotle distinguishes two classes of parts that are for the sake of the whole (I) generative and (II) instrumental parts (which

This gives reason for thinking that there are wider and narrower conceptions of substantial nature underlying the thoughts expressed both in *GA* and *IA*. Biological explanations point to a gradation between features that constrain and explain the presence of other features while the latter features themselves constitute further constraints for the presence of other parts.[486] However, what may be considered as a constraint of the substantial nature for explaining the presence of locomotive parts, may be explained by appealing to some more basic features that constrain its presence in the organism. Equally the presence of locomotive parts may be part of the constraints that explain the presence of further features necessitated by their presence.

Teleological considerations relating the size of the organism's body, or the position of that body, to the locomotive parts display this structure.[487] The size of the body and the erect position of humans are regarded as constraining, as parts of the substantial nature, the possession of a specific kind of limbs. However, they themselves are explained by appealing to further, more basic constraints regarding the substantial nature of the kind. So the shape of the body, i.e. its upper portion,[488] is determined by the fact that it is the seat of the heart which is the first and most central part in the generation of the organism. Similarly the erect position of the human body is a feature constrained by its substantial nature being that of a

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are not parts of the end or nature at least if construed narrowly) he concedes that it is not easy to keep track of the distinction (if one relies merely on the temporal priorities).

[486] For instance, the explanations of horns in *PA* III.2. Animals have horns for the sake of protection and strength. (662b26-7) In the case of some kinds where horns are such that they cannot accomplish this task, nature provides some additional mode of protection, e.g. in the case of bison the emission of excrement, in the case of deer velocity (663a17-18). Further, the larynx is said to be for the sake of breathing, while the neck is there for the sake of larynx and oesophagus. (*PA* II.3 664a15-20)

[487] For the size of the body and its limits as determined by the contribution of both male and female see *GA* IV.4 772a5-11. There is some more or less determinate proportion between the two contributions corresponding to each natural kind (IV.4 772a17 ff.).

[488] When Aristotle talks of the size of the body as part of the substantial nature of the organism he must be focusing on the upper portion of the body, the lower portion being of a lesser value. According to the *GA* 743b19-20 the upper portion is marked off first and is growing out of more honorable nourishment while the lower portion receives its growth relatively late in the process of generation.

rational animal. (*PA* II.10 686a25-30) Yet the erect position itself is a feature of the substantial nature constraining the kind of locomotive parts the kind possesses.

These examples confirm that the threefold division between parts of living things is compatible with a division between wider and narrower conceptions of the substantial natures of kinds. This weak understanding of the distinction between different kinds of features does not trivialise its explanatory power. For, first, it does not undermine the fact that there is a structure of priorities between features of organisms such that some features are explanatorily more basic than others. Secondly it does not undermine the fact that there is some basic explanatory level, which is not explained by appealing to any more basic features. So on the one end of this structure there are features which cannot be explained by alluding to more basic ones, and on the opposite end there are features that do not play any major explanatory role vis-à-vis further natural characteristics. The former include the generative/nutritive capacities of organisms which ground teleology and are parts of the core substantial nature of the kind. These capacities are part of the strong natural features of the kind. As we saw earlier the principle that nature does best (NP*) operates within the constraints imposed by SNF and it does not itself determine what features are part of the SNF. Nature does best given the determinate traits implied by the strong account of the substantial nature of the kind.

1. Introduction

In the explanation of the natures or essences of biological kinds, Aristotle seems to rely on some basic natural characteristics that form part of the core substantial nature. This nature includes the explanatorily most basic characteristics of the kind. This set of fundamental features includes the determination of this nature as something directed to an end identified with the various activities characteristic of the kind. In chapter 8 we saw that teleological assumptions, such as (NP*), are operative within the limits of the core substantial nature of a kind. If there is no good external to the organism, such as the good imposed by some universal natural order or an intelligent demiurge, which imposes end-directedness on organisms, what grounds this principle must be internal to them.[489] This internal element could be identified with the generative/nutritive capacities of organisms. It was suggested that the definition of life and living things in terms of their nutritive and generative capacities as well as the close association between these two is what warrants the application of teleology, as well as the evaluative language that goes with it, to living things.

On the one hand the nutritive powers of an organism, *qua* responsible for its development, determine this development as a co-ordinated system of parts with specific

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[489] This is the subject of a long controversy. One possible way to divide the views is the following. On the one extreme the claim that Aristotle is committed in some sort of cosmic teleology of which the teleology displayed by natural kinds is a part, i.e. that the good in the case of living things is dependent or overridden by a higher good, is argued for by Furley (1985:177-182); Kahn (1985:183-205); Preus (1990:471-490); and Sedley (1991:18-30). Proponents of the opposite claim, that teleological explanation in living things is not dependent on some universal notion of the good, could be divided into two classes. On the one hand proponents of a 'reductionist' understanding of the good in teleology, including Gotthelf (1988:113-138) and Depew (1997:209-227), claim that considerations concerning the good are not defining for teleology but derivative or secondary. By contrast a non-reductionist approach, such as the one taken by Cooper, argues that forms of living kinds exist as goals and therefore whatever promotes their persistence is good, although they serve no further universal good. [Cooper (1982:197)] Broadie whose account could be classified here, points to an ambiguity in Cooper's account between a propositional and a predicative way of representing goals: i.e. whether the goal for 'a relatively undistiguished blob of matter (e.g. frog spawn)... is *that there should be (or have become) a frog* [propositional]; or is it rather *to be (or have become) a frog*. The former represents an end logically appropriate to the Universe as agent.' She argues that the analogy with craft is intended to emphasize that the latter is the case in teleological explanations of living things. (1990:395-6) For the claim that Aristotle's metaphors in biology do not import a *Demiurgic* or a *Cosmic Nature* see Lennox (2001b:183-4).

interrelated functions. The fact that the order of the formation which is the outcome of the nutritive activity reflects the needs of such a system suggests that the organism's nutritive activity consists in a teleological plan. On the other hand, the powers that contribute to this development are associated with the reproductive powers of the organism. The exercise of reproductive capacities aims at the same actuality as nutrition. The reproductive powers of the organism are conditioned by the aim of preserving the natural kind form in full actuality. If so, then it seems that what sanctions teleological explanation of organisms' parts is ultimately dependent on the teleology exemplified at the level of the reproduction of organisms, and on the association of these generative capacities with the nutritive ones in the developing entity.[490]

In what follows I examine, first, the plan characterising the activity of the nutritive capacity in organisms. Secondly, the relevant distinction between two kinds of nutritive material, serving different stages of this plan. Then, in the light of this distinction, I will turn to the identity between the two capacities. I conclude with some more general remarks on the relation between the identity claim and teleology.

2. Priority between the parts and nourishment

The generative faculty is closely associated with the nutritive one in the account of the gradual formation of the parts of organisms. This process, or at least some of its stages, could, arguably, be classified as stages of the generation process. On the other hand the plan and the active power that determines the formation of the parts belongs to nutritive soul. So let us look on this process again.

The general principle underlying the account of the formation of the organism is that nature, doing nothing superfluous, would never form a part too early or too late in the

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[490] This does not mean that the generative nutritive capacity sufficiently defines the essence of living kinds. Living kinds possess other, higher capacities, necessary for differentiating between them and sufficient for defining their essence. Humans, for instance, may be defined as rational living

development.[491] Nature forms each part when there is a reason for that part to be developed. Moreover, the order of formation is dictated by whether and when the material available for the formation of each part is available. Nature does not act on any chance material but on different kinds of material appropriate for each part. So, in *GA* II.6 Aristotle introduces a division between different kinds of nourishment each one appropriate for different kinds of parts: (a) nutritive or first nourishment (744b12-3, 744b34), and (b) growth-promoting or second nourishment. (744b34)

The first kind of nourishment is purest because better concocted and (some of) it is included in the seminal or nutritive residue. Out of it the most honourable parts are formed, namely those that have a share in the supreme controlling principle. (744b13) By this Aristotle must refer to the heart, the brain, some of the homeomerous parts (e.g. flesh, bones and sinews), to the upper part of the body, and perhaps the initial outline of the parts. That is to say, the first nourishment serves the formation of the parts which were classified either as generative and parts of the end, or as parts of the end *tout court*.

The second kind of nourishment is formed out of inferior material, namely leavings and residues. (744b15-6) It serves the formation of the necessary parts that were classified as purely instrumental: the lower parts of the body and the less honourable homeomerous parts such as hoofs, nails, horns and bills. Finally, the growth of the bulk of a living thing is also achieved by means of this kind of nourishment. (744b35-6, 745a1-2)

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things. However, the higher capacities are sufficient, partly because they presuppose the nutritive-generative ones. The point is emphasised by Furth. (1988:152)

[491] See the (PF) principle in chapter 8 section 3. In general the order of the formation of animal parts according to *GA* II.6 has the following structure. First the heart, or its analogue, is formed. It is followed by the formation of some homeomerous parts (blood-vessels, bones, flesh and sinews). (744b28-30) Then, the upper portion of the body is marked off, while the lower portion receives its growth relatively late. (743b19-20) Once the parts are traced in outline, 'they receive their various colors and softnesses and hardnesses.' (743b20-22) This plan confirms the idea that nature does nothing superfluous: 'As nature does nothing that is superfluous or pointless, it is plain that she will not do anything too late or too soon, for in that case what was done would be either pointless or superfluous. Therefore the separation of the eyelids and the ability to move them must coincide in time.' (744a37-744b2) Since the completion of the eyes comes late, due to the large amount of concoction required by the brain, it is late in the course of the development that the organism has the power to move the eyelids, and it is only then that the eyelids are separated.

Thus the division between two kinds of nourishment is parallel to the three-fold division of animal parts. The latter division is based on teleological considerations which are grounded on differences in priority/honour between parts depending on whether they (I) control, or (II) generate and control, or (III) sub-serve these functions. It is because of these differences that nature needs to use different kinds of nourishment for forming the different parts. A passive power for the formation of the corresponding parts corresponds to each kind of nourishment, namely nutritive or growth–promoting.

But now it seems to be an Aristotelian principle that for different kinds of passive powers there are different active powers operating on them. In *GA* II.4 740b26-741a1 Aristotle argues from the analogy between two kinds of passive powers to two kinds of active ones.[492] So one would expect a similar argument from the disanalogy between the two kinds of passive powers here. Namely, that if there is a difference between two kinds of passive powers, namely the powers attributed to nutritive and growth–promoting nourishment, there should be a corresponding difference between the active powers operating on them. But all there is in the text is Aristotle's argument that the active nutritive power of an organism resembles the intelligent plan devised by an agent organising the life in a household by dividing the labor required:

> Like a good housekeeper, nature is not accustomed to throw anything away if something useful can be made out of it. In housekeeping the best of the food available is reserved for the freemen; the residue left over from this as well as the inferior goes to the servants, and the worst of all goes to the domestic animals. Here then is an instance of a mind, external to them, acting so as to provide for their growth. In the same way nature is at work within the creatures themselves that are being formed. (II.6 744b16-23; Peck's tr.)

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[492] An equivalent principle must be at work in his discussion of sexual differentiation in *GA* IV 1 765b26 ff.. The two sexes are differentiated by the ability of the male, and the inability of the female to secrete the residue in a pure condition. Since there is an instrument for each faculty there must be an instrument for each one of the sexes (765b36-766a4). The secreted residues -first and honourable and second and less honourable- are themselves instruments for nutrition and growth respectively. These two corresponding powers are obviously connected but this does not mean that they are identical. And the fact that there is a difference between two kinds of instruments used for nutrition and growth respectively suggests also a crucial difference between the two powers.

Nature manages and directs the appropriate nourishment to the corresponding parts. The nourishment that oozes through the blood vessels and the several passages in the several parts and is distributed by means of the heat, is managed and directed by the nutritive soul which is a constitutive part of the nature of the organism. The nutritive power is intimately linked with a detailed plan determining the stages of generation, a plan for selecting,[493] dividing and using the right proportions of the differen t kinds of nourishment available to it.[494] Although no division of labour between different kinds of active powers of the nutritive capacity is explicit here, the analogue suggests that such a division may be in the background. Similarly, in the household analogue there must be different kinds of active powers associated with freemen, servants and domestic animals.

A further passage that deals with the same issue is found in *dA* II.4, although it is far from clear whether it relies on a distinction between two different kinds of active powers. In the following passage where Aristotle accounts for the phenomena attributed to nutrition, explicitly distinguishes two kinds of powers:

> But being food and being capable of producing growth are different; for it is in so far as the ensouled thing is something having quantity that food is capable of producing growth, but it is in so far as it is a particular and a substance that it is food. (416b11-15; Hamlyn's tr)

The way these two powers are introduced in the first line of the above passage suggests that they are passive powers. So, intake of food produces two different kinds of processes each one falling under different categories of being. On the one hand food has the (passive) power to contribute to the maintenance of the actual persistence of the substance. On the other hand food has the (passive) power to contribute to the quantitative alteration of the

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[493] Nature is selecting and dividing the useful from the non-useful material, which is left over as a residue, and which is used later on for the formation of purely instrumental parts (III.11 762a16-18).

[494] The similarity extends further, since in both cases there is a symmetric three-fold division. In the household case there are freemen, servants and domestic animals while in the case of the organism's growth there a gradation of parts with respect to their importance of the whole organism: 'and [nature] constructs [a] flesh and the bodily parts of other sense-organs out of the purest material, whereas [b] out of the residues she constructs bones and sinews and hair, and [c] also nails and hoofs and all such things, which means that they have to wait till nature has some residue to hand, and that is why they are the last to be constructed' (II.6 744b23-28).

bulk of this substance. Equally the subject in the two processes must be different (or at least it must be the same subject under two different descriptions). In the former case the subject is a substance, an individual organism. In the latter it is a quantity. However, these two passive powers correspond to two different aspects of the ensouled thing. The one belongs to it as a quantity, the other belongs to it as a particular and a substance. What is not clear is whether the agent needs to be different in the two cases, or whether Aristotle thinks so.

In any case what is cleat is that Aristotle wants to maintain a distinction that divides between a threptic process linked to the substantial being of a living thing and an *auxetic* process linked with quantitative alterations only. The former will be related to the reproductive activity. Furth labels the first activity as *metabolic self sustenance* and argues that it constitutes the criterion for the temporal continuity of biological objects.[495] The reason for the distinction must relate to a difference between the two processes with respect to change. The growing process consists in changes that fall under the category of quality. Metabolic self-sustenance instead is a process that contributes towards avoiding any changes with respect to the substantial nature of the organism. If there was a change in that respect, the organism should change with respect to its substantial nature. The organism would be destroyed and something essentially different from it would be generated. But this contradicts our, or at least Aristotle's, convictions concerning the persistence of organisms, i.e. the individuative criteria for organisms.

So in the *dA* passage Aristotle is drawing a sharp contrast between two aspects or processes of nutrition. Again there are no explicit claims concerning the active powers

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[495] See Furth (1988:159-160). The significance of this capacity is attested, according to Furth, in the location of the 'reproductive or ''genetic'' faculty in threptic psyche.' He concludes: 'thus the ''*primary psyche*'' in which threptic and genetic are conjoined, represents a twofold capacity of certain biological objects with regard to transtemporal persistence. The threptic, in the individual, is the basic faculty of self-mainenance across time, and works by metabolic exchange of materials with the environment... The genetic, in the individual, is the faculty of self-duplication... But looked at the species level (or *sub specie speciei*), the genetic faculty of the individuals becomes... a threptic capacity of that eternal being (*on*) the species.' (1988: 160-161) For the distinction between the two faculties, but also for a general detailed account of nutrition see also King (2001:49-58).

operative in the two kinds of processes. But even if the same kind of active power is involved in both processes there must be some difference in the way it is involved in them. The difference must be such that it will allow to maintain the contrast between two different nutritive phenomena: (a) the phenomenon whose result is the persistence of the organism (for what we consider as its life-span); (b) the phenomenon whose result are quantitative changes of this organism while it persists. Although the *dA* claim is made in a different context from the context of the *GA* remarks on nutrition, there is no reason to claim that what motivates the distinction in *dA* is irrelevant to the *GA*. It is reasonable to assume a similar contrast is present in the latter work. If so then in order to understand the identity between generative and nutritive faculties we should be clearer about the role of the nutritive faculty. Does it cover all nutritive phenomena or only one subset of them? Let us examine this question in terms of an objection to the identity claim.

3. The identity between nutritive and generative soul

The identity between nutritive and generative capacities of a living thing appears more or less explicitly in two passages considered above.[496] This identity between nutritive and generative parts of the soul faces at least one serious difficulty.

The difficulty could be put thus. The activities of nutrition and generation seem to point to two different kinds of change.[497] On the one hand, the changes suffered by an organism in the process of growth are quantitative alterations. So they should come under the category of quantity. Generation, on the other hand, is a case of coming to be of a

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[496] *GA* II.1 735a15 ff. and II.4 740b-a3; cf. *dA* II.4 416a19 ff..

[497] One place where premises for this objection can be found is *GC* I.5 320a8-15. The argument here will be that it is not nutrition and reproduction that belong to different categories but increase (*auxisis*) as something different from nutrition and reproduction (*See* Buchheim (2001;205 n. 16, also 206-7 & 229-31). This of course depends on whether a distinction between nutrition and increase is clearly maintained by Aristotle. Although *dA* II.4 presses their difference there are places, e.g. *GA* II.4 740b30-741a2, where the wording does not suggest that αὔξησις is used for quantitative changes only, nor that it is always in contrast with τροφή and the qualitative or substantial change related to it. So Peck for example argues in his *GA* Appendix 'the same causes that are responsible for delimiting

substance. Hence changes falling under that heading must be classified under a category of being different from quantity. Further, if the two processes point to different kinds of changes, the power responsible for these two kinds of change should normally be attributed to two different soul-faculties, and this puts pressure on the identity claim.

Nevertheless, given that Aristotle distinguishes two kinds of nutritive processes, quantitative and substantial ones, it does not follow that every change brought about through nutrition is a quantitative change. Nor that every kind of nutritive process constitutes a change. For not every nutritive process that relates to the living thing as a substance is a substantial change. If it were then it should be either a generation or a destruction. But, the phenomena which Aristotle wishes to classify as part of the metabolic self-sustenance of living things are preserving the substance without either creating a new or driving the existing one to destruction.

So a solution to the above problem can be proposed in terms of the above distinction between two different kinds of nourishment, which is used in two corresponding sets of nutritive phenomena. (*GA* II.6 744b34 ff.) Some nourishment provides 'both the whole and the parts with being' while some nourishment is responsible for the growth of the living thing, i.e. responsible for the quantitative alterations that occur in the organism. As mentioned above the distinction may relate to the formation and development of different kinds of parts. Or it may also point to the distinction between the process of the formation of a part and its subsequent growth.[498] Further it relates to nutritive phenomena that follow the development of the parts, and that relate to the living thing as a substance and enhance its persistence, i.e. the phenomena constituting the self-sustenance of the individual as a substance. Further, the distinction it may also mean that there is a distinction between two

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the young creature qualitatively are also responsible for its quantitative development.' He identifies these causes with the activity of *pneuma*. (1956:579)

[498] In the latter case the growth promoting aspect is not responsible for the formation of a part but just enables the existing parts to get bigger.

active powers, two soul-faculties, to which the activity of bringing about the corresponding processes could be assigned. If so then the objection concerning the identity between nutritive and generative faculty could be answered. When Aristotle speaks of the close association between generation and nutrition he has in mind one kind of nutritive phenomena, namely those that relate to living things as particulars and substances, while where there is a difference between nutrition and generation it is a further set of nutritive phenomena that are in focus, namely those that relate to the living thing as a quantity.

This interpretation, however, begs the following question. If there is a radical distinction between two kinds of nutrition, what links the two, and makes it reasonable to call them by the same name? It seems that the interpretation establishes the association between nutrition and generation by inviting a gap within nutrition itself. I will come back to this point after considering some evidence for this interpretation.

It is unclear whether Aristotle sought a solution in exactly those terms, since there is no explicit division in the *GA* between two kinds of nutritive faculties. However, two positive reasons for thinking so is that, first, Aristotle at least hints to such a distinction, in other contexts.[499] Secondly, he is aware of the difficulty concerning the two kinds of change involved here. As we saw he introduces the distinction between two kinds of nourishment in order to accommodate or resolve this complication. This is also clear from the explanatory work the distinction does in the following lines:

The sinews are constructed in the same way as the bones, and out of the same materials, viz. the seminal fluid or ''nutritive'' residue. [500] As for nails, hair, hoofs, horns, bills, cocks' spurs and any other such part, these are formed out of the supplementary or ''growth-

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[499] The passage which is closest to a distinction between growth-promoting and nutritive soul faculties is, as far as I know, *JSVM* 4 469a24-30 where he speaks of three different parts of the soul: sensitive, growth promoting and nutritive. Similarly in *NE* I.7 1098a1f. where Aristotle lists different kinds of life-functions, nutrition and growth promotion are mentioned separately presumably as different life-functions.

[500] This sounds as if part of the body is formed from the semen, contradicting the well-known doctrine that the material elements come from the female. This issue will be addressed in the following section.

promoting'' nourishment, this additional nourishment being obtained from the female and from outside. (II.6 744b37-745a4)

The two kinds of nourishment originate from different sources and are destined to be consumed for the formation of different parts. Sinews and bones are formed by the nutritive residues that provide the parts of the animal with being, i.e. their formation is part of the process of metabolic self-sustenance. Nails, hoofs etc. are formed out of 'growth-promoting' nourishment coming either from the female or from outside. These parts are included in the class of animal parts that are for the sake of the organism as purely instrumental, and which are contrasted to essential parts of the organism (see ch. 8 section 3). If they are inessential their formation is not really part of the generation process, as the generation of a living thing with a specific substantial nature. This distinction is supported by the fact that parts in the latter class, hair, nails, hoofs etc., continue to grow as long as they are parts of the whole animal. (745a11-12) By contrast, essential parts which belong to the former class have a limit and grow up to a point.[501] This points, again, to the division between parts developed as a result of the process of substantial generation and parts developed as a result of some quantitative alteration.

If it is an Aristotelian principle that there is one separate instrument (here kind of nourishment) for every ability or faculty, the two kinds of nourishment must imply two different faculties (whatever the exact relation between the two turns out to be). But I know of no text where such a strict distinction is set out, explained in detail and justified.[502] This observation may offer an answer to the puzzle raised above, namely what accounts for the unity between the two kinds of nutritive activity, if the phenomena for which it is responsible are carefully and consistently distinguished. Aristotle's silence with respect to the

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[501] Bones set the limit of the animal's size. (II.6 745a7-8) The fact that bones grow up to the size characteristic of the natural kind should not be understood as a mere quantitative change. The exact size may vary, within certain, upper and lower, limits constraining it, which are formal characteristics of the kind.

[502] *JSMV* 4 469a24-30 and *NE* I.7 1098a11 ff. just point to that direction.

distinction between two active powers of nutrition on the face of the distinction of two different kinds of changes, suggests that he thinks there is a reason for not dividing the two activities into two kinds of nutritive active powers such that it will be impossible to regard nutritive soul as one, unified capacity. What are the reasons for resisting this move is unclear. It may be that after all it is not unreasonable to think that the same general capacity can explain changes in different respects, i.e. with respect to substance and quantity, when it operates with different kind of material. Especially if such an account offers the ground for the close association between nutrition and generation. An association which is crucial for explaining the teleological behavior of living things.

To conclude, the division between two kinds of nourishment follows the division between parts of the substantial nature of the animal (both generative/instrumental and parts of the end) and purely instrumental parts of the organism. First nourishment is linked with the former and more honourable parts, while second nourishment is used for the latter ones that are auxiliary and less honourable. (744b12 ff.) Given this division, the identity between generative and nutritive powers does not entail confusion between changes that are substantial generations and changes that are quantitative alterations. The two kinds of changes are identified with different processes of the nutritive capacity of the living thing, the one related to parts of the substantial nature and the other related to purely instrumental parts. The generative capacity need not overlap with both activities. We could interpret the identity between generative and nutritive capacity as limited to the first class of nutritive phenomena, namely those that relate to the being in actuality of the whole animal and its most honourable parts. If this is possible then the difficulty with which we began can be resolved. The difference between quantitative changes produced by the nutritive soul and substantial changes produced by the generative soul is accounted for by one sub-set of the nutritive phenomena. By contrast the claim associating generative and nutritive capacities

rests on a disjunct sub-set of nutritive phenomena, namely those in which the nutriment consumed is first/seminal nourishment (similar in kind to the residue present in generation).

4. A further distinction between nutritive phenomena?

Even if the distinction between nutritive and growth promoting phenomena is drawn in the way suggested above, there is a further complication regarding the former kind of phenomena (the ones classified as substantial, not-quantitative changes). The difficulty can be illustrated by the different stages of nutrition emphasized in *dA* and *GA* respectively.

There seem to be a difference between two distinct stages in the nutritive processes which were identified as parts of metabolic self-sustenance. The difference arises when we look at the context of the *dA* and *GA* discussion. On the one hand, the nutritive process described as metabolic self-sustenance of the substantial nature, as the *dA* suggests, cannot constitute a change. For a change in that respect would imply a substantial change. In the *GA*, on the other hand, as far as consumption of food (either from outside or through the umbilical chord) enhances the formation of parts of the substantial nature, the nutritive process contributes to a change. It contributes to the gradual changes that follow the setting of the embryo, and are directed towards the completion of the generation process. Let us label this process *substance-formative* activity. Since no organism generates itself and since the active power that drives these changes is the internal principle of the organism, these changes cannot be identified with generation strictly speaking. Therefore, this activity must be the result of the nutritive function of metabolic self-sustenance.

However, it cannot be the result of this function if typically the results of metabolic self-sustenance constitute a different kind of process identified with the maintenance of a mature organism in good/healthy condition. This may suggest a further sub-division of nutritive phenomena. There may be two kinds of non growth-promoting nutritive phenomena: (a) those that constitute parts of the *substance-formative* activity, and (b) those

that constitute parts of the activity of metabolic *self-sustenance* (though this supposition is beyond what can be established by the texts we are examining). Nevertheless, what is certain is that the processes that could be classified under (a) or (b) are for Aristotle crucially different from quantitative, growth-promoting changes. Further the activities under (a) could be described either as nutritive, for the distribution of nourishment is constitutive of this activity, or generative, for in fact what Aristotle describes in the *GA* is the gradual process of the generation of a living thing by means of the gradual development of its parts. This may be part of Aristotle's motivation for identifying nutritive and generative capacities in living things.[503]

That the two substantial processes distinguished above, namely metabolic self-sustenance and substance-formation processes, should be classified under a common category is also suggested by the following consideration. With respect to metabolic self-sustenance there is no proviso, in the *dA* passage, that the food consumed is of a different provenance from the one consumed for growth-promotion. The two kinds of passive powers operative in the two processes, nutrition and growth-promotion are essentially different but there is no hint that the material must come from different sources. However, in *GA* II.6 744b37-745a4, quoted in the previous section, which deals not with metabolic self-

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[503] This claim needs to be examined by taking into account Aristotle's way of individuating changes. According to one line 'what makes the type of process the one it is is the goal it is directed to achieve'. [Charles (1991:115) and (1984:23-25)] If the end of the two types of processes is the form of the mature individual organism in full actuality, this is a reason for holding on to the identity thesis. However, it seems that more is needed, more than just the end state, to individuate processes. [Broadie (1982a:127-8)] Aristotle's definition of change in *Physics* III.1, 'process is the actuality of what is potentially so and so insofar as it is potentially so and so', does not only point to the direction of change but also to the fact that the subject is of such a nature that, given the right conditions, it will be directed to that direction. (1982a:124) This is required, according to Broadie, for establishing the reality of change: 'as he [Aristotle] conceives it, the specific and definite character of a process is given by both its *termini*, and nothing exists or takes place that is not of a definite nature. Hence before the process is over (at which point it no longer exists), and indeed from the outset, it must already ''have'', in some sense, an *ad quem* regardless of the outcome.' (1982a:128) If so then in order to associate the two processes, there must be not only a common direction, but also the same kind of (passive and active) potentialities. The discussion in the main text suggests that, in nutrition and generation, the same passive potentialities are involved, i.e. the same kind of nourishment. The active potentialities also seem to be, specifically, the same, though more discussion is needed in the light of the III.1 definition of processes.

sustenance but rather with the formation of substantial parts, it is argued that the material must come from different sources. Why is this distinction concerning the provenance of nutriment necessary in the explanation of substantial-formative process in the *GA*, but unnecessary in the discussion of metabolic self-sustenance in the *dA*? The reason may have to do with maintaining the sharp contrast between on the one hand these two sub-processes of the nutritive faculty and on the other growth-promoting process that result in quantitative alteration.

In the case of metabolic self sustenance and growth promotion the contrast is obvious because self-sustenance does not involve any change in the shape of the substance whereas growth does. So there is no need to dwell on the difference in the origin of the material used for the two kinds of processes. Further, it may be that in the case of mature organisms no such distinction is needed, for the organism has the appropriate mechanism in place to transform the available material into material suitable for two different kinds of processes. In other words the organism may have the power to bestow different kinds of passive power to the material processed through concoction.

By contrast, in the case of the formation of the parts of the substantial nature of the organism the process involves a number of changes and thus the contrast with growth-promotion is not as sharp. So there is room for confusion between the two kind of processes. Furthermore, given that the organism in this case is still developing and not a fully mature organism which can process appropriately the material, some other device need to be developed in order to explain the different passive powers possessed by the materials consumed in the two kinds of processes. The difference in origin between the two kinds of material may just be such a device. So, by insisting that there are two different kinds of material Aristotle, perhaps, aims at retaining the contrast between nutrition and growth-promotion even in cases where the two processes seem to be most similar, i.e. in the formation of animal parts.

This suggestion is re-enforced by Aristotle's insistence that the material out of which the more honourable parts are made comes from a different source, despite the following difficulty. If there are two different kinds of material destined for the formation of more and less honourable parts, and the material for less honourable parts comes from the mother, it is not clear where the material out of which the more honourable parts are formed is coming:

> Here is a puzzle which may be raised. If (1) the blood is nourishment, (2) the heart is the first thing to be formed, and when formed contains blood, and (3) the nourishment comes from outside, from whence did the first nourishment enter? Well, perhaps after all it is not true to say that all nourishment comes from outside. In the seeds of plants there is some nutritive matter, which at first has a milky appearance; and it may be that in the same way, in the material of the animal, the residue left over from its construction is present as nourishment for it from the outset. (II.4 740b3-8)

Aristotle solves the puzzle by suggesting that heart includes some nourishment from the outset, similar to the nutritive stuff contained in the seeds of plants. This nourishment, nutritive blood contained in the heart, does not come from outside, and thus it must come from the female.[504] However, Aristotle had already discussed the female's contribution, concluding that the female contributes the material out of which the fetation is formed.[505] Given this conclusion, the above puzzle should not arise. For it is not really a puzzle but rather a problem that Aristotle's theory can accommodate. The puzzle can be a genuine one only on the following assumption. The material needed here serves a different purpose from the one served by the female material contribution discussed so far and thus either (a) it *seems as if* it cannot come from the female or (b) it *cannot* come from the female. The reason that it *seems to be*, or *is*, different from the material contributed by the female must be that it is a more honourable kind of nourishment, suitable for forming the parts of the end (e.g. the heart, the brain or the bones). Aristotle needs here two kinds of material, m_1 and m_2, differing in such a way that it is possible to argue that the formation of the core substantial

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[504] 'Outside' in the above passage refers, among other things, to the nourishment provided by the female through the umbilicus (740b9-10). But this is not the original contribution of the female. So this use of 'outside' leaves open the possibility that the nutritive matter comes from the *original* contribution of the female.

(more honourable) parts by means of m_1, is essentially different from the process of the formation of the instrumental (less honourable) parts or of the quantitative variations by means of m_2.

The puzzle's resolution by means of the claim that the material is left over from the initial setting of the fetation suggests that it only *seems* that the material cannot come from the female ((a) above). So the female contributes two different kinds of material, one serving the formation of honourable parts and one provided through, but perhaps not only, the umbilicus chord which serves the formation of the less honourable ones. However, the seed-analogy does not confirm that unambiguously. First, in plants there is no separation of the sexes, thus the seed is analogous to the compound of male and female contributions. Second, even where there seem to be such a separation at II.4 738b35-7 in the case of plants analogous to the separation in animals, the analogue of the female contribution is the soil (while seed is linked with the male contribution). So the passage does not conclusively show whether (a) or (b) is the correct reading, which leaves open the, highly controversial, possibility that not only the female contributes nutritive material.

Whatever the exact solution, the introduction of the above puzzle emphasises the division between nutritive activities that are substance-formative and activities that are growth-promoting, and Aristotle's intention of accounting for it. Although it is clear that there is material available from the outset, he still feels he needs to give an explanation where this first nourishment, the material out of which the honourable parts are formed, is coming from. There are two different kinds of nourishment available, from the outset, their consumption results in the formation of different kinds of parts in the organism, suggesting two different lines of activities inside the organism. The first one is of a growth-promoting nature. The second is involved in the nutrition of the essential parts of the organism. It is operative in their formation, and thus it is operative in the process that aims at completing

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[505] *GA* II.4 738b1-4; 738b11-15; 738b20-21.

the generation process, and finally it is also operative in the metabolic self-sustenance of that organism. Therefore it can be identified as the generative/nutritive activity of the organism.

5. Further reasons for the identity between generative and nutritive capacity

Apart from the evidence presented above concerning the identity between generative and nutritive capacities of living things there are at least two philosophical considerations motivating this claim in the context of Aristotle's analysis of nature and living things.

First, Aristotle's account of the generation of living things starts from the principle that nature, i.e. the sum of the natures of kinds of living things, aims at avoiding infinity and always seeks an end. The way regularity is secured and infinity avoided in the case of generation of living things is through reproduction of living things possessing the same form as their parents. So generation proper is reproduction. As we saw in ch. 6 Aristotle endorses two principles according to which things similar in kind can only come from similar generation processes, and similar generation processes can be initiated only by things similar in kind acting as efficient causes. Having the form of a living thing entails being an efficient cause for something identical in form, as well as being generated by something identical in form. It follows that a mature specimen must also be an efficient cause for the generation of an organism similar in form by means of the same generation process. This is the way the generative capacities of living things are defined. Living things must possess a capacity for bringing to life an organism which possesses the kind-form in full actuality.

On the other hand, the entity that is developing is the same, and *a fortiori* of the same substantial nature, as the one it is developing into. It necessarily possesses the same essential properties. So it must possess the same power in virtue of which the mature living thing can act as an efficient cause. Parent, offspring and mature individual must share that power in some way. One way to secure this is by linking the power for reproduction to the power for nutrition. The source of change in virtue of which the developed one is an efficient cause initiating the development of a new entity, the source of change that drives the developing

living thing into the developed one and the source of metabolic self-maintenance are one and the same. Let us consider what the separation of these powers would entail.

If the power characteristic of the generating parent as efficient cause is different from the power that drives the development of the developing one, i.e. the completion of the generation process, two problems arise. First, how if at all will the organism acquire the former, i.e. the reproducing power? A further explanation will be needed to explain the inheritance of this power by the offspring. What else could generate it, other than something similar to the generative capacity of the parent?[506] If it is the capacity of the developing entity which is identified as its internal principle of change, why not claim that the two capacities are of a similar nature?

Secondly, if the active power of generation, the generating power of the parent, and the active power in development, the nutritive power in the offspring, are different, then the claim that the generating power is the generating cause would not be valid. For there would be something different from it, namely the nutritive power of the developing organism, driving the change.[507] That is to say, if the process of nutrition is divorced from the process

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[506] A similar *aporia* is expressed in *GA* II.4 740a8 ff. with respect to the question whether the first principle, i.e. the heart, is present from the first moment of generation: '[the fetation] must have a first principle from which also the subsequent ordering of the animal's body is derived. Otherwise, supposing this principle is to come at some moment from outside and take up its position at some point later on, then we may well be puzzled at what moment this is to happen...'. This first principle is an agent in generation since it is from here that the movement is secreted (738b10ff.). *Pneuma* on the other hand does not play any role in the secretion of semen or residues. (II.4 737b27 ff.)

[507] This point could be made in more general terms. If an entity is produced for the sake of some state s_1, where s_1 includes the capacity to produce the same process that brought it about, then this process cannot be directed by some independent agent. For then it is this independent agent that brings about s_1.

This point relates to the wider question of the reduction of teleological processes into intrinsic mechanistic causes responsible for bringing about the end. Wright in his account of teleological processes criticises Taylor's drive 'to make animate natural tendencies irreducible to intrinsic-mechanistic regularities' for this is a result of a misconception of the distinction between accidental and essential. (1976:67) Taylor argues that the order which is the result of the teleological process must be a factor in its own production, and that 'the events productive of order in animate beings are to be explained not in terms of other unconnected antecedent conditions, but in terms of the very order which they produce.' (1961:5) The reason is that the involvement of order in its own production is what is essential to this production whereas mechanistic laws can only be contingently related to this production. So there can be no systematic reduction to mechanistic causes which could account for the coming to be of the order explained. Instead in Wright's (T) schema the fact that this order is a 'factor in its own production... is quite independent of an underlying mechanism.' (1976:68) Further,

of generation, then either the generation of the organism is carried out by its nutritive powers and therefore it is not dependent on the active power of the generating parent, or the generation process is activated by the generating parent and therefore the nutritive powers of the developing entity have no role to play in the process. Either way the account of generation will seem fragmented and incomplete. This is avoided by blocking the unwelcome consequences through the identity between nutritive and generative capacities.

This point could be set out in a more detailed way. The offspring is the subject of a number of formative changes that constitute the stages of its development. The generation of an organism in one sense is not completed with the setting of the fetation. During the subsequent developmental stages the organism is growing into a mature individual. Whether these stages are part of the generation process strictly speaking may be doubtful.[508] What is certain is that during these stages the generating parent does not exercise any active influence. Instead it is the organism's central organ, the heart, that directs the process of the formation of the parts at this stage. The activity of the heart that directs these formative stages of the developing organism (as well as guaranteeing the metabolic self-sustenance of the developed organism throughout its life-span) is identified with the nutritive activity. The link between generative and nutritive activity establishes the continuity between the process of the setting of the fetation and the formation of its parts. For, first, as we saw above, if there was no connection it would not be completely wrong to say that the generative power does not generate, or at least it is not that which completes the generation process. Secondly, why should the substantial nature of an organism need two different capacities for one and the same activity, namely the completion of the generation of the organism? As we saw in

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as Wright puts it, 'the only worry one could raise by invoking the accidental status of a property like the goal-directedness of behaviour [qua reducible to mechanistic causes] is an uncertainty about whether one could count on its persistence. And clearly this does not depend on irreducibility: intrinsic-mechanistic regularities are after all regularities.' (1976:68-9) Although Wright may be right, what the last statement shows is that if one does not believe in such mechanistic regularities, then the worry concerning the accidental/essential distinction is justified. This, I take it, is close to Aristotle's position.

the case of the central organ, which is the principle of different soul-faculties, nature follows some sort of principle of parsimony, according to which the simplest way of doing things is also the best possible one.[509] The identity of generative and nutritive capacity implies a simpler account of generation and self-maintenance of living things than does their separation. So this must be the way appropriate to the nature of organisms.[510]

But there is also a different set of considerations that suggest the identity claim. The nutritive faculty is the principle for forming the organism's parts and arranging them as a well-functioning system. The organism's parts are for certain functions and they are formed in order to serve these functions. So the process depends on the good these functions and their interrelation produce in the organism as a whole. If the nutritive capacity is linked to the generative one this offers ground for maintaining that the activity of the nutritive capacity aims at some good because the activity of the generative capacity is aiming at some good. The parts are for certain functions that will benefit the organism, i.e. the parts are formed such as they are because this is the best possible outcome that can be produced given the needs of the organism and the materials available. So the nutritive capacity is constrained by some version of the (NP*) principle. But now this may be so because the activity of the generative capacity of the organism is directed by the (NP*) principle, and there is continuity between generative and nutritive capacities of the animal. So the link

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[508] See Furth (1988:160).

[509] Nevertheless there is at least one passage, in *PA* IV.6, where Aristotle seems to argue from a contrary principle. The principle is that it is better not to have the same instrument for dissimilar uses, when this is possible. Then he argues that 'where it is possible for two things to be used for two functions without impeding each other, nature is unaccustomed to making things as does the coppersmith who, to economize, makes a split-and-lampstand; but where ths is not possible, nature makes use of the same thing for multiple functions.' (683a22-5)

[510] Another reason motivating the identity between the two is the following one proposed by Furth: 'the primary psyche in which threptic and genetic are conjoined, represents a twofold capacity of certain biological objects with regard to transtemporal persistence.' (1988:160) The threptic is the faculty of an organism for self-maintenance across time, i.e. a preservative process. The genetic although a faculty of self-duplication at the level of individual organisms, when looked at the species level it can be understood as a threptic capacity of the eternal being, the species: 'at this level it is also not a generative process (the species does not reproduce) but a preservative one.' (1988:161)

between generative and nutritive activity can provide part of the explanation why the nutritive power's activity aims at benefiting the organism.

The above consideration is partly motivated by Gotthelf's analysis of teleological statements concerning function in terms of teleological considerations concerning generation. Gotthelf analyses the relation of '*x* being for the sake of *y*' by means of the relation '*x* coming to be for the sake of *y*'. The relation between the two kinds of teleological statements is defined by means of the following bi-conditional: 'a part A is for the sake of doing something B iff A in fact does B and has come to be for the sake of doing B.' [Gotthelf (1987b:238)] So there should be an explanatory link between A actually doing B and its being made for the sake of B. Now the nutritive faculty is what secures that A does B (through its activity of metabolic self-sustenance). The generative faculty is what is responsible for the fact that A comes to be for the sake of B. If the latter is linked with the former, this goes some way towards explaining why the nutritive activity should secure that A does B. It does so because the generative activity makes A for B. With a slight alteration, taking into account the whole organism, *W*, the analysis will be equivalent to the following formulation:

(*t*1) a part A of *W* is for activity B, iff (i) A does B and,
(ii) *W* comes to be in so as to possess A for doing B.

The nutritive capacity through metabolic self-sustenance sustains *W*, and A in particular, in such a condition that A can do B. But also the nutritive capacity is responsible for generating *W* and completing its formation which includes A (by selecting and directing the nourishment with the corresponding passive power for forming the various parts), so that A can do B.

Gotthelf's analysis of 'being for the sake of' in terms of 'coming to be for the sake of' introduces the theme of the two kinds of teleological explanations, relating to generation and function, and their interrelation. Gotthelf's understanding of the relation between the two follows Wright's explanatory schema of functions. For Wright, if a function, F, of

something, x, is to do Z, two conditions must be satisfied: (I) Z must be a consequence (result) of x being there, and (II) x is there because it does (results in) Z. [Wright (1976:81)] As Gotthelf notes the difference between Aristotelian biological explanation and an evolutionary explanation is that in the latter the 'because' in (II) points to an explanation in terms of natural selection. (1987b:241) In Aristotle the explanation will refer to embryonic development as a result of the activity of the substantial nature of the kind.[511] In that respect the teleology of the generation of organism is, at least part, of what explains the teleology of functions.[512] This suggests a close link between the two forms of teleological statements and also a link between the active powers that are responsible for the activities that give rise to these two kinds of teleological statements.

6. Conclusion

The nutritive capacity of an organism is such that its activity ensures the self-maintenance of the organism in full actuality. So what the generative capacities guarantee at the level of the animal kind, the persistence of active organisms of that kind, the nutritive capacities guarantee at the level of the individual organism.[513] Thus, in one sense, the activities of the

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[511] According to Gotthelf this analysis entails the priority of individual over the species: 'Since only individuals can come to be, the thesis defended in this section makes the individual prior to the species for purposes of explanation.' (1987a:242) But this is not necessarily so, for generation itself may be dependent on something prior such as the persistence in activity of the form of the kind.

[512] This is in disagreement with the relation between the two forms of teleological explanation as discussed by David Charles in (1991:104-5). He argues that Aristotle makes no attempt to argue that either '(I) processes of formation of organisms which occur for the sake of the whole organism or (II) parts of organisms (or features of those parts) which are [also] present for the sake of the whole organism... is more basic.' (1991:104-5) So the two levels of teleological statements remain relatively independent, and this threatens the unity of the theory of the four *aitia*. Charles distinguishes two further forms of teleological statements relating to purposive agency, namely (III) actions done for the sake of something, and (IV) objects that exist for the sake of actions done for the sake of something. If a unified account of final causes is to be formulated, Charles argue, the relation between (III)-(IV) and (I) and (II) need to be clarified. With respect to the relation between (I) and (II) Charles argues that although no priority is evident in *Phys.* II.8-9, the passages in *PA* I.1 640a22 ff. and 640b1-3 suggest the priority of being over becoming. Gotthelf in his analysis of these passages makes the case for the contrary thesis that the teleological character of the being of living things is dependent on a teleological character of their generation. (1987a:239-240)

[513] Nature always seeks an end and therefore aims at preserving the same forms of living things, where this is possible. This is achieved through reproduction. So the reproductive activity is closely linked to the eternity of the species and grounds teleology at the species level. But now the faculty

two capacities are aiming at the same kind of activity and this provides a reason for linking the capacities themselves. This might be the impact of the *dA* claim that whatever the animal does, it does it for the preservation of the species. (*dA* II.4 415b1-2) The *dA* claim is justified if what is responsible for the activities of a living thing, activities that constitute its substantial nature, is closely linked to its generative capacities.

Further the identity between the generative and nutritive powers of living things by entailing that whatever the animal does, it does it for preservation suggest a path for discovering what a living thing is. The biologist has a criterion for distinguishing those parts that form part of the essence or substantial nature from those that do not. In order to discover the nature of a living thing, he has to look at a hierarchy of functions, activities and parts aiming at preserving the life of the members of each kind. These activities and the parts that control them will be parts of the nature or essence of the living thing. To this end Aristotle takes into account the order of development of the animal. This is useful only because development is determined by the hierarchy of the functions of the parts. Organisms are for the sake of some functions because they come to be for the sake of being able to accomplish these functions. The most generic activity in the case of organisms, i.e. the one attributed to all living creatures, is that of the nutritive soul, whose functions are reproduction and the assimilation of food. Reproduction is an activity aiming at the continuation and hence persistence of the kind. Assimilation of food aims at the growth and preservation of the organism. So the power common to these two functions must be the first and most widely shared faculty of the soul (*dA* II.4 415a25), representing a minimum for them being living things.

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responsible for this activity is assigned another role, nutrition, directing the development of the organism's parts. So the same faculty grounds teleology at the level of the formation of the organism according to the functional role of its parts. This suggests that things that are generated according to natural teleology are teleologically functioning systems. Teleology through natural generation is implanted into the individual living things of the sub-lunary world.

I would like to conclude by summarising some of the conclusions of the discussion of nature and essence in the previous chapters. I will bring together these features by following three threads that guided to some extent the interpretation of the Aristotelian texts considered here.

The first one. Aristotle draws a severe distinction, in the *Topics*, between predicates that signify what a subject is and predicates that qualify a subject in some secondary sense. The former are predicates that signify the essence of a subject and out of them the definition of that subject is composed. As we saw in ch. 2, this distinction runs parallel to a distinction between the first category of predication, where a predicate is predicated in the what-it-is of a subject or answers to the question what this subject is. It is not clear whether this latter distinction supports the former, but it is clear that, at least in the early works, they stand or fall together. The way Aristotle remains silent on any more basic concepts or considerations supporting these distinctions suggests that, at least in the early works, they are some sort of primitive notions, or so it was argued in ch. 3. What justifies them or supports them is some confidence in the intuitions that can guide one in drawing them, or get at least a first grasp of these distinctions, and the *topoi* collected in the *Topics* for testing and refining them. The rudimentary methodological remarks concerning the study of differences and similarities are based on the same kind of intuitively plausible observations.

These considerations point to a number of further features that remain, to some extent, present throughout works which are generally considered to be later, such as the *APo* -as argued in ch. 4-5. The first such feature has to do with the pre-eminence of a common genus between a number of subjects that constitutes the subject-genus of a scientific discipline which aims at investigating what these subjects really are. The common-genus constrains the investigation in two related respects: first with respect to the sort of explanations that can explain what these subjects are, secondly with respect to the priority relations between the predicates and subjects considered by the discipline. The second important feature relates to the usefulness of division as an instrument for investigating the differences between the subjects. The third relates to the order of priorities holding inside each subject-genus which

are reflected to the order of unqualified knowledge of the subject, an ideal that the understanding of that subject must follow. Although all three features play some role in the *Analytics*' account of definition, *APo.* II focuses on the central role of explanation in definition. What counts as essential depends on explanation. And the relations of natural priority that determine the order inside the subject-genus are strongly influenced by explanatory concerns. This does not imply and out and out rejection of the features pre-eminent in the previous works. First, the order of natural priority with respect to explanation does not imply an irreconcilable incompatibility with the order of natural priority employed in the *Topics*. The naturally prior generic elements can be said to have some role in explanations and therefore must enjoy some priority in that respect. Secondly, the importance of the common genus and of the practice of division is still relevant both to the *Analytics* and to the introductory book of the *PA*. So although Aristotle's views develop, and his notion of explanatory grounds offers a more robust criterion for demarcating the essence of a subject we do not need to read that as a sudden change of paradigm.

The second thread relates to the evidence that points to a development in Aristotle's writings, not necessarily in Aristotle's thought, with respect to what constitutes the nature or essence of living things. A development that displays some similar structure to the development outlined in the previous paragraph. Aristotle's definition of the nature of living things which drives towards the identity of this nature with their form, suggests a sharp distinction between features that constitute this nature and features that are mere consequences of it, i.e. that they are according to nature. (ch. 1) This distinction will be drawn in terms of formal features against material ones. It might seem that the *Analytics* imply the same picture by insisting on the role of essences as explanatory indemonstrable principles from which further features of the subjects considered by a scientific discipline can be derived. This distinction will be drawn in terms of features that can serve as *explanantia* against features that can serve as *explananda*. However, the evidence from the biological works and the actual explanatory work Aristotle undertakes there, suggest that

such a distinction cannot be wholly captured by any one of the above two pairs, i.e. matter and form or *explanans* and *explanandum*, in quite the sharp manner these programmatic texts suggest. Biological explanations present us with a complex explanatory structure. Pre-eminence is given to teleological considerations. Nevertheless, material aspects are often explanatorily important as well. Further, the explanatory structure could be conceived more like a chain of explanatory links rather than a number of *explananda* derived from one central explanatory feature. Given this structure it is not straightforward where to draw the line between what constitutes part of the essence of the entity considered. What is more, the vocabulary that refers to essential features is used at various levels along this explanatory chain and not just at one very basic one. Faced with this complexity there are at least two possible moves, which come to the same conclusion from two different angles. First, to hold that the notion of essence, strictly speaking, applies only to a very basic feature of living things that constitutes their core essential nature, their unified soul-faculties. This is the ultimate end of the natural changes a living thing undergoes and this is the object of definition. There is no other conception of definition or essence for organisms. Second, to hold that Aristotle in his biological works is not aiming at giving definitions of natural kinds or discovering their essence. His objective is to arrive at well-founded explanations of the structure or order of the natural changes livings undergo. Definitions and their machinery are foreign to the aims of biology.

But there is yet a third possibility for which I tried to make a case in ch. 8. Namely that the implication of the complexity of the structure of biological explanation is that there are weaker and stronger conceptions of the substantial natures or essences of living things. And that this implication rather than resulting in a rejection of the concept of essence, deflates the, perhaps earliest and tighter, understanding of this concept in the *Analytics*. Perhaps the difference between this line and the previous two comes down to a matter of emphasis, where this emphasis for the first two lines is placed on the discrepancies between the

concerns in the two bodies of text, while this third line puts the emphasis on some continuity between them.

The last set of considerations relates to the implications of teleology in the natural world for the priority relations that structure the natural changes organisms undergo, and the specification of their substantial nature. Already in the *Physics* II.1 definition of nature as an inner principle of change, surfaces the requirement that the efficient cause of the development of organisms must be included in their substantial natures. This is what secures the regularity of generation in the natural world. In *GA* I.1, as argued in ch. 5, this characteristic is what differentiates natural from unnatural generation, and guarantees the persistence of living things that belong to kinds reproducing by way of natural generation. What constitutes the basis of this teleological structure of the changes involved in the generation of living things is controversial. At least part of the argument in ch. 7 was that the order of these changes is not reducible to some material element, such as vital heat, but that it irreducibly depends on the substantial nature of an organism. This nature consists in the structured way the functions of the mature organism are organised. This introduces a second level of teleological explanation relating to function, in addition to that relating to generation. In ch.8 I considered some positive evidence concerning what features or parts of the organism are prior with respect to the teleological structure of the natural changes an organism undergoes. Finally in ch.9 I argued that the mechanism which constitutes the basis that grounds these teleological relations are the closely associated generative and nutritive soul faculties of organisms. These two faculties ultimately unify two levels of teleological explanations relating correspondingly to generation and function. In the end the way the *Physics* II.1 requirement with which this paragraph began is fulfilled depends on the association of these two faculties.

Appendix I: The method of formulating definitions at work in Physics *II*

The procedure of formulating a definition implied from the description of the study of differences and the similarities in *Topics* book I, is the following. One begins by taking subjects differing in species and tries to isolate their common properties.[514] Then one aims at this common property that captures mostly what the entities in question are. This is their common genus. Once this is established one proceeds by collecting necessary differences between the subjects, differences according to which the common genus is determined. These are differentiae out of which real definitions can be formulated. The definitions are formed by attaching the differentiae belonging to each to the common genus. The account composed in this way signifies the essence of each subject.

An example of this method can be found in *Phys.* II.4-6 discussion of the concepts of chance or luck (τύχη) and spontaneity (αὐτὸματον).[515] Aristotle looks first for the common characteristics between the two concepts then he tries to find out the differences of the items in question, in order to define their essence. He sets three questions as the target of his discussion of the two concepts: (1) in what way the two concepts fall under the general concept of explanation, i.e. what is their relation to the four causes defined in *Physics* II.3, (2) whether luck and chance are the same or different, and (3) in general what each of them

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[514] It may turn out that the entities are not one in genus. The only initial requirement is that the entities resemble in some respect so that it is possible to spot generic common features between them. It may turn out that the entities fall under genera which are further removed from each other.

[515] The study of coming to be in *Physics* I.7 also seems to follow this method: 'let us, then give our own account of coming to be, in the following way. And first let us deal with all of coming to be; for the natural procedure is to speak first about what is common to every case, and then to study what is special to each case.' (189b30 ff.) The discussion begins with the endorsement of the widely held view that there is coming to be. Then the first step is to examine what is common between cases of this phenomenon, i.e. different types of ontological subjects as species of coming to be. The common element is their common generic predicate. The second step is to examine the differences that characterise the different subjects: e.g. (a) differences between cases of simple and compound things coming to be (I.7 199b32-4), or (b) differences between cases where there is coming to be *simpliciter* and cases where an underlying subject persists throughout the change (I.7 190a32 ff.). The differences arise because coming to be as a general phenomenon has a set of characteristics exemplified differently in the various cases. The generic nature provides the background against which the differences of those subjects are to be discovered. The genus, being what is mostly in common

is. (II. 4 195b34-6; 196b7-9) An answer to (1) will place luck and chance under the appropriate kind of causes. An answer to (2) will provide the differences that divide the two concepts (if they turn out to be different. An answer to (3) will provide the definition of each one.

Aristotle proceeds first by answering, in II.4, the existential question, namely whether there is such a thing as luck and chance.[516] Then, in II.5, he distinguishes between two kinds of things that come into being (γιγνὸμενα): (a) things that come to be by necessity and always in the same way (196b10-11, 196b12-3), and (b) things that come to be in the same way for the most part. (196b10-11) Neither things under (a), nor things under (b) could be the outcome of luck or chance. However, since there are things that do not fall in either of these categories, which are said to come to be by luck or chance, it follows that luck and chance must be some kind of thing.[517] Once chance and spontaneity are placed in this horizontal division of things that come to be, Aristotle puts forward another division that cuts across the previous one: (I) some things happen for some reason while, (II), some do not; and some of those that happen for a reason (Ia) come to be according to προαὶρεσις while (Ib) some do not. Aristotle then takes the intersection of the class of things that happen neither out of necessity, nor for the most part and the class of things that happen as if there was a reason for them to happen.[518] He ascribes to luck those things that come to be as if they were the outcome of thought. (196b23-4) The classification can be represented thus:

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between the different cases provides constraints for the various qualities that characterise the cases falling under it.

[516] This is a discussion of the 'if it is' question according to the *APo.* terminology. Aristotle discusses mainly the opinions of authorities, such as the Atomists and Empedocles, but he also seems to refer (196b6) to popular beliefs. Once the existential question is answered, Aristotle closes chapter 4 by restating the questions set out in the beginning (196b7-9).

[517] Cf. 196b13-5. Aristotle justifies this claim by saying that those things that do not come to be out of necessity or do not come to be for the most part are the outcome of luck, and those things that come to be by luck are things that either do not come to be out necessity or do not come to be for the most part (196b16-7).

[518] Kalfas points out that Aristotle does not claim that 'among things that do not come to be out of necessity or for the most part there are some that come to be for a reason', but 'there are some for

Things that come to be (γιγνὸμενα)		out of necessity	For the most part	κατὰ συμβεβηκὸς
For a reason	κατὰ προαἰρεση ἀπὸ διανοὶας	1	2	3
	ἀπὸ φὺσεως	4	5	6
Not for a reason				

Table 2.

Cases falling under box 3 and 6 are defined, at 196b23 ff., as causes κατὰ συμβεβηκὸς (coincidental causes) and produce events that occur by chance or luck, by contrast to cases where the cause is *per se* or in the absolute sense (as defined in *Physics* II.3). Aristotle distinguishes the two by arguing that the latter are determinate while the former indeterminate,[519] and he adds:

As has been said, then whenever this [coincidental causation] occurs among events of the sort that are for a reason the events [that have these coincidental causes] are said to result from chance and luck. The difference between chance and luck will be determined later; we may take it as evident for the moment that are found among events of the sort that come to be for something. (II.5 196b29-33)

Aristotle here places the cases of luck and chance under their common genus. They are cases of things that happen coincidentally although they seem to happen for a reason. This generic characteristic of events that happen by chance and spontaneity is what is mostly predicated in their what it is, and it is the outcome of a comparative analysis of things that happen necessarily or ususally, on the one hand, and things that happen neither necessarilly nor ususally. An analysis of the differences between chance and spontaneity will follow, although here there is no commitment on whether they are co-ordinate species of the

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which there might be a reason.' (1999:104) This shows that Aristotle is focusing on those things that could have come to be for a reason even if actually did not came to be for a particular reason.

[519] Causes in the absolute sense are determinate while coincidental causes are indeterminate. Aristotle argues for this distinction between from the distinction between beings *per se*, i.e. in an absolute sense, and things that coincide with being *per se*. A man, for instance, is a man in itself, while he possesses an indeterminate number of characteristics that coincide in him, e.g. white, musical etc. Similarly, the builder is the absolute and determinate cause of the building of this house, whereas the white, the musical and all other characteristics that the builder posssesses, and which are indweterminate in number are coincidental causes of the building of this house (196b24-29).

common genus, or classes of things in different levels of generality (Aristotle will argue for the latter claim). In any case their differences, i.e. their essential characteristics, will follow from this initial generic predicate which is their most basic essential characteristic.

Next Aristotle derives the essential characteristics of chance. The first one is this: 'clearly then chance is a coincidental cause found among events of the sort that are for something, and specifically among those of the sort that are in accordance with a decision.' (197a5-6) This characteristic is just the specific way in which chance exemplifies the general characteristic of being the cause of things of the sort that happen for a reason. Both events that come under chance and events that come under chance display this common element: they are the causes of effects that could have come to be for a reason, although they might actually not come to be for a reason. Now in general, things that come to be for a reason are either the products of decision or products of nature. (196b21-2) The latter belongs to the realm of nature while the former to that of human activity.[520] Products of chance must fall either in the first class or in the second or in both. Aristotle seem to agree with the general opinion that attributes an event to chance when that event is considered as falling in the first class, i.e. when the event comes to be as the product of human decision. Hence, the essential characteristic that belongs to both chance and spontaneity, namely 'as if it was to be for something', is determined for chance in the following way: 'as if it was the product of human decision.' Since decision requires thought, 197a6-7, Aristotle derives a further characteristic of chance:[521] whatever is the product of chance could have been the result of thought.

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[520] On the other hand, things that come to be for something are either the products of decision or the products of nature. (196b21-2) The latter kind of teleology belongs to the realm of nature while the former to that of human activity.

[521] The fact that Aristotle uses the concept of thought in the definition of luck at 198a4, suggests that it is an essential characteristic, derivable from the connection between luck and decision. The notion of προαίρεσις as related to thought is examined in the *NE* 1113a10-12; 1139a31; 1139b4-5.

Aristotle distinguishes between two kinds of effects that are produced by chance. Chance can be good or bad depending on its results. Hence there are two kinds of events produced by chance depending on this evaluation. This property that divides the products of chance will be used for differentiating chance from spontaneity, which Aristotle holds is a wider concept and includes chance:

> For chance and its results are found in things that are capable of being fortunate and in general capable of action and that is why chance must concern what is achievable by action. A sign of that is the fact that good fortune seems to be the same or nearly the same as being happy, and being happy is a sort of action, it is doing well an action. Hence what cannot act cannnot do anything by chance. (II.6 197b1-6, Irwin's tr)

Action presupposes decision. So if someone is capable of action he is capable of making decisions. By contrast, inanimate things, beasts, and children cannot do anything by chance because they are incapable of decision. (197b6-8) Since chance relates to entities that are capable in themselves to be fortumate or not it is essentially divided into bad and good. Spontaneiy, however, applies both to things that happen to this latter category of beings and to the outcomes of chance. Therefore it is different and wider than chance.[522][523]

The method Aristotle follows in discussing chance and spontaneity bears the following similarities to the method introduced in *Top.* I. First he places the entities to which these concepts apply to the corresponding domain of reality. This is similar to the collection of premises in the *Topics*. Chance and spontaneity are causes of some sort. Then by specifying what kind of effects they are producing specifies the highest common genus to which only the products of these causes belong. This genus answers in the most basic way the what-it-is

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[522] Aristotle examines one more difference between spontaneity and chance. Spontaneity as a cause is usually external to its effect (while sometimes it might be internal), whereas chance is always internal in that the event produced could have been the result of thought by the agent. (197b18-22)

[523] Then Aristotle puts chance and spontaneity under the apporpriate species of causes: 'each of them falls under the sort of cause that is the source or the principle of motion. For in every case they are either among natural causes or among those resulting from thought.' (198a2-4) He also distinguishes luck and chance from any other causes by adding that they are indeterminate in number as opposed to other efficient cuases which are determinate. (198a4-5) By this he means that chance

question for these two concepts. It is the most basic because (a) it is the most general one, (b) all subsequent characteristics attributed to those two concepts are refinements and differentiations of it and (c) it constitutes the property that divides their nature from the nature of other causes. This genus correspongenus to what according to the *Topics* is the predicate that is mostly predicated in the what-it-is. Once, this common genus is established Aristotle examines the specific nature of chance by determining in what way the basic generic characteristic belong to it. Then he examines the differences between the two concepts. This examination is carried by contrasting the essential features of chance to features found in cases attributed to spontaneity. The resulting differences are certainly regarded as essential predicates and appear in the proposed definitions.[524] Independently of what is the exact definitions, what is clear is that they are formulated, at 198a5-6, only when the similarities and differences between them have been explored.

The above method reveals certain elements of Aristotle's conception of essential properties and essence in general, implied also by the similarity of the method described in the *Topics* and the method employed in the *Physics*. The essential properties of a subject are part of a network of properties that divide the genus common to that and other co-generic subjects. The common nature of those subjects is prior to the specific way in which the subjects exemplify this nature. Thus defining is a comparative enterprise. The natures or

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and luck are the sum of an indeterminate number of factors that intervene and produce an effect; precisely when this effect's absolute or καθ αὐτὸ cause is not actively producing it.

[524] (197b18-20, 198a5-6) This can be shown in two ways:

(a) The products of chance and spontaneity are essentially the events that could have been produced for something. If an event comes to be for something it is either produced by nature or by decision (i.e. by human agency). Products of chance are essentially those events that come to be as if they were the outcome of decision. Hence there must be a class of things that collects the cases of events which are essentially the events that come to be as if they were the outcome of nature. Aristotle does not identify spontaneous events with this latter class because he takes spontaneity to include both them and the events which are the outcome of chance.

(b) Both chance and spontaneity fall under the species of efficient causes. Efficient causes are either essentially natural ones or essentially causes that stem from thought. So those two essential properties that divide efficient causes into two diffferent species of efficient causes must apply to the causes that belong to chance and spontaneity. So the corresponding classes that are divided according to these two characteristics should possess them as essential ones.

essences of the subjects under a common genus consist in the diverse ways in which the common nature is determinated in each. Hence the essence of an entity is embedded in the network of the priorities between the predicates that sub-divide the genus. I shall now turn to this notion of priority and to the structure it implies for definitory predicables.

Appendix II: The interpretations of APo. II.13 96b15-25

The table below represents the steps of the method and the entities involved in II.13 96b15-25 according to the interpretations considered in chapter 5:

	Themistius / Philoponus	Pacius	Ross	Barnes (I)	Barnes (II)	Charles
Step 1	All infimae species		Primary infimae species (PIS)	All infimae species		Basic atomic species
Step 2	Definitions of those species					
Step 3	Assume the category under which the genus falls					Assume the genus
Step 4 (deriving proper attributes from first common primitives)	Deduce the differentia e of the species from similarities between the species which constitute the differentia e of the sub-altern genus	Deduce in itself incidentals from the first principles that are common to the primary and complex species.	Deduce the properties of the complex species from the primary attributes common to primary and complex species	Deduce the in itself incidentals from the essential predicates	Deduce the in itself incidentals from the common axioms	Deduce differentia e from the definitions of the atomic species
Step 5: the attributes of the things composed out of the *atoma* become evident from the definitions	The attributes of the genus will become evident from the definitiona l predicates of the infimae species.	Attributes of complex species composed out of the PIS follow from the definitions of PIS. For definition and what is simple is the source of everything & the properties belong only to the PIS *per se*, while to other species consequentially.		Attributes of the derived terms (DT) composed out of the primary terms (PT) become evident from the definitions of DT .		

Appendix III: The non-sufficiency of vital heat in spontaneous generation

According to the arguments advanced in ch. 7 vital heat is an instrument used by the natures corresponding to each of the natural kinds which aim for preserving the existence of these kinds through natural generation. What about Aristotle's account of spontaneous generation? Proponents of the reductionist account argue that the account of spontaneous generation confirms that vital heat is an unambiguously informing power.[525] Against this line I will argue that if vital heat were to be construed as sufficient for generation then we would not get a satisfactory explanation of spontaneous generation.

Spontaneous generation, a non-teleological phenomenon, poses challenging questions for the interpretation of teleology.[526] The challenge can be stated thus: spontaneous generation as characteristic of some natural kinds bears some similarities with teleological generation, while as non-teleological it must differ from normal teleological generation processes. This way of putting the problem suggests that an examination of spontaneous generation may offer some insight into Aristotle's teleology. Although this is in agreement with the view of some, Gotthelf has argued that the account of spontaneous generation offers no grounds for interpreting teleology.[527] Although I will follow, roughly, his interpretation of the phenomenon I will argue against his claim that an analysis of spontaneous generation offers no grounds for understanding teleology.

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[525] So, for instance, Freudenthal (1995:25ff.).

[526] That spontaneous or unnatural generation is a non-teleological phenomenon in the same way that natural generation is, is implied in *GA* I.1 715b7-16. (See chapter 6) The *locus classicus* for spontaneous generation is *GA* III.10-11, although there are other passages where Aristotle makes some remarks or examines briefly some aspect of spontaneous generation (*Met.* VII.9 1034a34-b8, *HA* V-VI, *PA* I.1 640a28-6). The first question is whether the remarks in the above passages form one unified account of the phenomenon or not. Even if *GA* represents the mature and fuller story of spontaneous generation there is disagreement over whether this account is consistent with Aristotle's metaphysical doctrines of causation and chance.

[527] For instance, both Lennox and Freudenthal take Aristotle's account of spontaneous generation as indicating or confirming a particular interpretation of teleology. Gotthelf is opposed to this claim (1989:185).

Gotthelf advances a stronger and a weaker claim against the usefulness of studying spontaneous generation for teleology. The weak claim is that a consideration of spontaneous generation cannot help us recapture the process 'by which Aristotle was led to, or the essential content of, his conception of final causality or his doctrine of natural teleology.' (1989:192) The stronger is that the *corpus* cannot 'give us some evidence that Aristotle reflected... on the implications of his mature theory of spontaneous generation either for his natural teleology or for much else in his natural philosophy and metaphysics.' (1989:191) It is only the stronger claim I am doubting. As Gotthelf himself admits, there seem to be an exception to the strong claim in *GA* I.1 715b7-16.[528] This is the passage on the difference between sexual and non-sexual generation discussed in chapter 6. It expresses Aristotle's views on the non-teleological character of spontaneous generation and suggests a sharp contrast between natural and unnatural generation. So Aristotle's strategy in this passage is in contrast with the claim that his thoughts on spontaneous generation have no implications for his teleology. Therefore, although Gotthelf's weaker claim might be true (i.e. that one cannot base an interpretation of teleology on the remarks on spontaneous generation) the stronger one (i.e. that that the remarks on spontaneous generation do not reflect at all Aristotle's convictions about teleology) might be misleading. More precisely, there must be some difference between sexual and spontaneous generation consistent with the teleological character of the former and the non-teleological of the latter. An account of the teleology involved in sexual generation should get some confirmation from the account of spontaneous generation. If so the remarks on the latter can be used as evidence for or against the reductionist interpretation of teleology in natural generation.

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[528] Gotthelf dismisses this passage as a 'small and only partial exception' without considering it in detail. (1989:191) However, as it was argued above, ch. 6, the passage is significant for dividing teleological generation from the non-teleological character of spontaneous generation. Moreover, the placement of this passage in the opening chapter of the treatise should alert us to the importance of the views expressed in it. If so, one would expect that the mature account of spontaneous generation will follow, roughly or not, Aristotle's views expressed there.

The controversy is over where exactly the difference between the two kinds of generation lies. Gotthelf poses the problem as a dilemma concerning the reducibility of spontaneous generation to some material substance.[529] The first horn is this: the process of spontaneous generation is reducible to the activity of the basic elements. If yes, then the difference between spontaneous and sexual generation is that only the latter is irreducible to the activity of the basic elements. But if so what warrants the irreducibility of sexual generation? According to the second horn of the dilemma, spontaneous generation is not reducible to the activity of the basic elements. It is due to the capture of *pneumatic* heat, which must be species-specific in order to generate the desired result. In that case the resulting problem concerns the element that differentiates between sexual and spontaneous generation, since irreducibility to element-potentials cannot do the job of differentiating between the two kinds of generation.[530] At least three different strategies have been proposed for avoiding this consequence.

Lennox's proposal is that what differentiates between the two generation processes is that the vital heat involved in spontaneous generation does not conform to what he labels the *formal replication model.* Formal replication refers to a process which grounds teleological explanations by reproducing the same natural kind form: 'processes [are explained] by means of their outcomes, because the form at the end of such a process is the form

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[529] Gotthelf writes: *Either* a spontaneous generation is due wholly to the simple natures and potentials of the elements... in which case it is unclear how Aristotle could have been so certain about irreducibility in the non spontaneously generated cases, *or* a spontaneous generation is due to the 'capture' from the environment of *pneuma*tic heat in the 'exact strength and amount' that would be present if it were a sexual generation, in which case it isn't clear how consistent with my interpretation, Aristotle could ascribe teleology to sexual generations but deny it to spontaneous ones. (1989:182-183)

[530] For irreducibility to the four element is according to this horn common between sexual and spontaneous generation. This consequence is used by Lennox as a reason against Gotthelf's interpretation of Aristotle's teleology. Gotthelf argues that what warrants teleology in sexual generation is an irreducible potential for the form that will result from the generation process (irreducible that is to the four basic elements). Lennox has now revised his views as expressed in the 1982 paper.

responsible for the process's having just the structure and direction necessary to proceed to it.'[531]

A different line is proposed by the reductionist. According to Freudenthal any kind of vital heat, whatever its origin, has the capacity to generate souls. This holds both for spontaneous and sexual generation. As a matter of fact there are different kinds of vital heat, thus accounting for the difference between kinds of living things generated spontaneously and kinds of living things generated by sexual intercourse. So the difference between the two generation processes is not to be explained by appeal to any further reason. Explanation stops at the level of different kinds of vital heat operative in the two kinds of processes. This, Freudenthal argues, further confirms the account of the formative role of vital heat in the natural world.

Finally Gotthelf suggests a third alternative. His strategy is to deny the antecedent of the conditional suggested by the second horn of the dilemma. The vital heat involved in spontaneous generation, unlike that involved in sexual generation, is not species-specific. This accounts for the difference between the two processes.[532] Gotthelf goes on to argue that vital heat of spontaneously generated animals has an undifferentiated, though equally irreducible, potential for form. This irreducible potential is some kind of *generic* potential, by contrast to the potential for a specific form imparted in cases of sexual generation which is species-specific.

Suppose one follows Gotthelf's answer. The question whether (a) the two different kinds of vital heat (species-specific and undifferentiated one) are explained by some further

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[531] Lennox in his 1982 paper argues: 'The semen operates like a tool of the parent. Its heating and cooling activity possesses a pattern, and that pattern is determined by the male parent's form. In parallel with craft production, the male parent, by means of having the form he does, determines the pattern of the heating contributed by the semen. This heat acts in its orderly way, and on the appropriate species-specific material so that it comes to exemplify the appropriate form. This form is thus ultimately responsible for the process that results in its being the organization of a specific organic body.' (2001b:231)

[532] Gotthelf states his conclusion thus: 'The vital heat 'captured' in early stages of spontaneous generation cannot be said to have a specific capacity to produce in the relevant material an offspring

difference or whether, (b), it is a basic fact of the natural world, remains. If (b) is the case and their difference is not further explainable, it seems that Gotthelf's line leans towards Freudenthal's interpretation. For in both cases the difference between the two processes is ultimately based on different kinds of vital heat appropriate for each one of them. If (a) is the case and the difference is indeed explainable by appealing to some further factor, then the only plausible candidate can be the substantial nature of the kind.[533] In this latter case Gotthelf's line seem to have some close similarities with Lennox's suggestion. In both accounts the natures of the kinds capable of self-replicating are ultimately responsible for the difference between spontaneous and sexual generation. Therefore this dilemma, concerning the way Gotthelf's proposal could be understood, is pressing for either an interpretation closer to the formal replication model or one closer to the reductionist account. The dilemma is pressing the question whether vital heat is an informing power or whether the potential for form is irreducible to the element of *vital heat*.[534] Let us now look at the relevant passage from *GA* III.11:

> Animals and plants are formed in earth and in liquid because there is water in earth, and air [*pneuma*] in water, and in all air there is *vital heat*; so that in a sense all things are full of soul. Therefore <living things> form quickly whenever <this air and vital heat> are enclosed <in anything>. When they are so enclosed, the corporeal liquid's being heated, there arises as it were a frothy bubble. The differences in regard to that which is constituted being more or less valuable in respect of kind are found in the enclosure of the soul-beginning. Of this both the place and the enclosed body are causes. (762a18-27; Gotthelf's tr.)

The reference to constitutions of living things that differ in value is crucial for the understanding of the formative power in spontaneous generation. That which is responsible for the variation in value must be the single most important factor in the formation of the

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of a given form, and the disanalogy with the sexually generated case is clear. The second horn of the dilemma is thus disarmed.' (1989:189)

[533] That is to say the form in the generating parent which forms through concoction a different kind of vital heat and then the form in the offspring that manages to maintain this kind of vital heat through which its parts are formed.

[534] It is assumed that it is not reducible to the basic elements. The *pneuma*tic heat of living things and the sun are contrasted to the element of fire. (*GA* II.3 737b33-a1) The hot substance in the

organism. Now every portion of earthy liquid, in earth or water, contains *pneuma*, and *pneuma* contains vital heat.[535] So there is soul or soul-heat wherever there is this kind of earthy liquid. Whenever the heat is enclosed in some portion of this material, this portion possesses soul and quickly becomes a living organism. Is this the result of the activity of vital heat (only)? The text says that whenever vital heat and the *pneuma* in which it inheres are enclosed, the corporeal liquid being heated, there arises a frothy bubble. What is the agent of this heating? Most probably the ordinary heat of the surrounding earth or water that does the heating. For, first, it is more likely that something outside the corporeal liquid is doing the heating, while *pneuma* and vital heat get enclosed. Secondly, as Gotthelf notes, the reference to place and the physical body as causes in l. a26 is a specification of the source of this heating. (1989:187) In different regions of the sublunary world there are different amounts of heat depending, presumably, on the predominant element in that region. Indeed differences in the surrounding heat in different regions result in different kinds of living things. (III.11 761b5 ff.; 761b22-4)[536] Therefore value either comes from the nature of that which encloses the earthy material or from the nature of the animal that is produced, i.e. the combined activity of vital heat and the material that encloses it.[537] At any rate, vital heat

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pneuma is said to be similar to the element which belongs to the stars, namely *aither* (737a1) This hot substance is generative whereas the heat of fire is not.

[535] Gotthelf argues, following Balme (cf. Balme 1962, 99), that vital heat in this case is a sort of generic, undifferentiated vital heat, though there is no such explicit qualification here. (1989:187)

[536] This reading requires that the reference of *toutou* in a26 which is what the agency of place and enclosed body is exercised upon is not vital heat (or the organising of vital heat). As Gotthelf puts it *toutou* can only refer 'either [to] the nature of that which encloses the vital heat and is responsible for the kind of animal that is produced from the process (if one takes, with Lennox, *to sunistamenon* as antecedent), or the production of that very kind of animal itself rather than some other (if one takes the entire sentence as antecedent)' (1989:189).

[537] See Gotthelf's formulation of the two alternatives. He claims that in either case it is the enclosing material which is responsible for the corresponding value (1989:189). I think his wording is misleading for in the second alternative it is not just the enclosing material which is responsible but also the activity of vital heat in the physical substance, though not by itself.

is not the ultimate source of value in the generation of less or more honorable kinds of organisms.[538]

Thus vital heat is not the only or ultimate factor for the formation of different kinds of living things, whatever its contributory role may be. This conclusion is weaker than, though compatible with, Gotthelf's, namely that vital heat in an organism in process of spontaneous generation is [not] specific to the kind of organism being generated. But it is in agreement with an interpretation that takes it that it is not vital heat but some other factor that determines the nature of the generated living thing. Therefore, the differences between spontaneously generated living things and living things generated by sexual reproduction cannot be ascribed to differences in vital heat not further explained by some more basic factor active in the generation process. They must be ascribed to what encloses the vital heat in spontaneous generation and what regulates vital heat in copulation (i.e. the form of the generating living thing acting as an efficient cause in generation).

Moreover, what entails that forms of some kinds of living things are efficient generative causes while some are not seems dependent on the efficient causes operative in their own generation and on how the activity of these causes conforms to the regularity aimed by nature. Where a generation process conforms to nature's principle of avoiding infinity the living thing is an efficient cause for the reproduction of its kind, and the kind is of a higher value.[539] In cases which depart from nature's aim, like those of spontaneously generated things, the things produced cannot act as efficient causes in generation and are considered to be of a lesser value. The opening chapter of the *GA* (I.1 715b3 ff.) offers one reason for thinking that what ultimately explains the difference between the two kinds of

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[538] If so then two factors contribute to the formation of the living thing: (a) the enclosing body and the vital heat and *pneuma* enclosed in it and (b) the surrounding heat. There is no suggestion that the differences in value depend directly or solely on the vital heat enclosed.

[539] So the difference ultimately depends on the value of the species-form of the generated thing. Copulation is a necessary requirement and so is differentiation of sexes (although the latter is explained by its being instrumentality for soul-faculties of higher value). (II.1 732a5-7; see also the misplaced paragraph at II.1 732a12-25)

generation processes is whether the process accords with the teleology inherent in nature. Nature seeks the self-replication of a kind-specific form through sexual reproduction. That is because nature always seeks to avoid infinity and sexual reproduction of animals which do not replicate the form of the kind implies an infinite series of successive generations of living things differing in kind. Reproducing living things conform to the teleological norm that characterises the natural world. So their form, being more honorable, is a source of change able to reproduce an offspring of the same kind and therefore participate in the divine and eternal in the only way which is open for it. By contrast, the forms of spontaneously generated things constitute a disruption of the natural order, in that they run against nature's aim for finitude. They are therefore less honorable and unable to engage into sexual reproduction since this would cause disruption by introducing infinity in the natural world.[540]

If this is right then it is not the case that every instance of vital heat carries equal generative powers. Aristotle explains this difference by appealing to a general characteristic of some forms that conform with the principle that nature avoids infinity and always seeks an end. What constitutes the difference between different kinds of vital heat is the form of the kind, in that only some forms can produce the kind of vital heat instrumental for sexual reproduction. The difference between kinds of vital heat involved in spontaneous and sexual generation is due to their source, that which controls and regulates this heat, e.g. the heart in the case of sanguineous animals. The heart itself is a part of the form/end that uses vital heat as an instrument in the generation process. If so it is the form that produces a kind-specific heat in the cases of sexual generation. The account of spontaneous generation implies that in normal generation processes, while not in cases of spontaneous generation, the form is active in terms of imparting a *logos* or a principle of change through the movements of vital heat for the generation of living things similar in kind. So, to conclude Aristotle's remarks on

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[540] See, however, the points made about generation *GA* II.8 esp. 748a8 ff., which seem to go against the general argument of I.1 concerning copulation.

spontaneous generation offer indications that vital heat, in itself, is not a formative power which is not further explainable in terms of an explanatorily more basic element.

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